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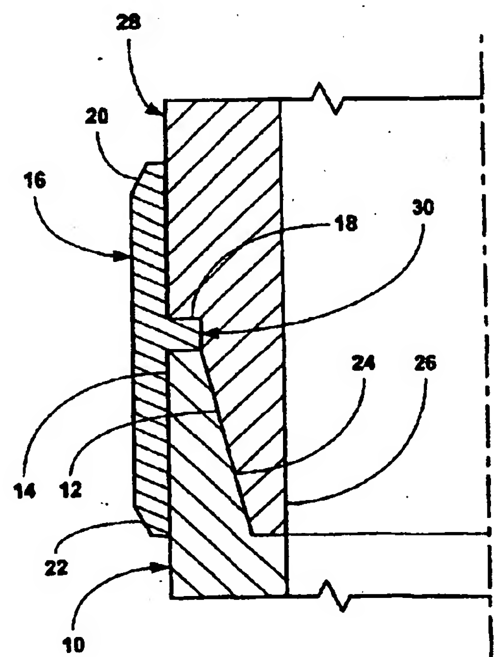
(54) Abstract Title: **Protective sleeve for threaded connections for expandable liner hanger**

(57) A tubular sleeve (16) is coupled to and overlaps the threaded connection between a pair of adjacent tubular members (10 and 28). The adjacent tubular members (10 and 28) are then radially expanded and plastically deformed.



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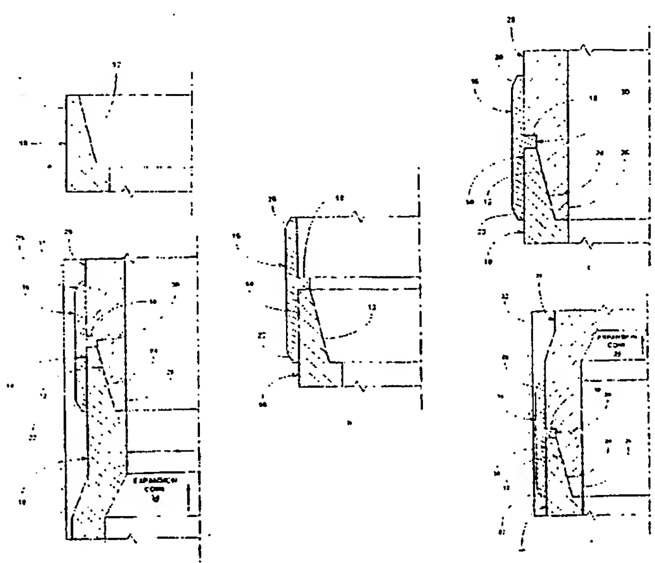
(54) Title: PROTECTIVE SLEEVE FOR THREADED CONNECTIONS FOR EXPANDABLE LINER HANGER



(57) Abstract: A tubular sleeve is coupled to and overlaps the threaded connection between a pair of adjacent tubular members.

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PROTECTIVE SLEEVE FOR THREADED CONNECTIONS FOR EXPANDABLE LINER HANGER

Cross Reference To Related Applications

[001] The present application claims the benefit of the filing dates of (1) U.S. provisional patent application serial no. 60/397,284, attorney docket no 25791.106, filed on 7/19/2002, which is a continuation-in-part of U.S. provisional patent application serial no. 60/372,632, attorney docket no. 25791.101, filed on 4/15/2002, which was a continuation-in-part of U.S. provisional patent application serial no. 60/372,048, attorney docket no. 25791.93, filed on April 12, 2002, which was a continuation-in-part of U.S. provisional patent application serial no. 60/346,309, attorney docket no. 25791.92, filed on 1/7/2002, the disclosures of which are incorporated herein by reference.

[002] The present application is related to the following: (1) U.S. patent application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, (3) U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, (4) U.S. patent application serial no. 09/440,338, attorney docket no. 25791.9.02, filed on 11/15/1999, (5) U.S. patent application serial no. 09/523,460, attorney docket no. 25791.11.02, filed on 3/10/2000, (6) U.S. patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, (7) U.S. patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on 2/24/2000, (8) U.S. patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, (9) U.S. patent application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, (10) PCT patent application serial no. PCT/US00/18635, attorney docket no. 25791.25.02, filed on 7/9/2000, (11) U.S. provisional patent application serial no. 60/162,671, attorney docket no. 25791.27, filed on 11/1/1999, (12) U.S. provisional patent application serial no. 60/154,047, attorney docket no. 25791.29, filed on 9/16/1999, (13) U.S. provisional patent application serial no. 60/159,082, attorney docket no. 25791.34, filed on 10/12/1999, (14) U.S. provisional patent application serial no. 60/159,039, attorney docket no. 25791.36, filed on 10/12/1999, (15) U.S. provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (16) U.S. provisional patent application serial no. 60/212,359, attorney docket no. 25791.38, filed on 6/19/2000, (17) U.S. provisional patent application serial no. 60/165,228, attorney docket no. 25791.39, filed on 11/12/1999, (18) U.S. provisional patent application serial no. 60/221,443, attorney docket no. 25791.45, filed on 7/28/2000, (19) U.S. provisional patent application serial no. 60/221,645, attorney docket no. 25791.46, filed on 7/28/2000, (20) U.S. provisional patent application serial no. 60/233,638, attorney docket no. 25791.47, filed on 9/18/2000, (21) U.S. provisional patent application serial no. 60/237,334, attorney docket no. 25791.48, filed on 10/2/2000, (22) U.S. provisional patent application serial no. 60/270,007, attorney docket no. 25791.50, filed on 2/20/2001, (23) U.S. provisional patent application serial no. 60/262,434, attorney docket no. 25791.51, filed on 1/17/2001, (24)

U.S, provisional patent application serial no. 60/259,486, attorney docket no. 25791.52, filed on 1/3/2001, (25) U.S. provisional patent application serial no. 60/303,740, attorney docket no. 25791.61, filed on 7/6/2001, (26) U.S. provisional patent application serial no. 60/313,453, attorney docket no. 25791.59, filed on 8/20/2001, (27) U.S. provisional patent application serial no. 60/317,985, attorney docket no. 25791.67, filed on 9/6/2001, (28) U.S. provisional patent application serial no. 60/3318,386, attorney docket no. 25791.67.02, filed on 9/10/2001, (29) U.S. utility patent application serial no. 09/969,922, attorney docket no. 25791.69, filed on 10/3/2001, (30) U.S. utility patent application serial no. 10/016,467, attorney docket no. 25791.70, filed on 12/10/2001; (31) U.S. provisional patent application serial no. 60/343,674, attorney docket no. 25791.68, filed on 12/27/2001; (32) U.S. provisional patent application serial no. 60/346,309, attorney docket no 25791.92, filed on 1/7/2002; (33) U.S. provisional patent application serial no. 60/372,048, attorney docket no. 25791.93, filed on 4/12/2002; (34) U.S. provisional patent application serial no. 60/380,147, attorney docket no. 25791.104, filed on 5/6/2002; (35) U.S. provisional patent application serial no. 60/387,486, attorney docket no. 25791.107, filed on 6/10/2002; (36) U.S. provisional patent application serial no. 60/387,961, attorney docket no. 25791.108, filed on 6/12/2002; and (37) U.S. provisional patent application serial no. 60/391,703, attorney docket no. 25791.90, filed on 6/26/2002, the disclosures of which are incorporated herein by reference.

Background of the Invention

[003] This invention relates generally to oil and gas exploration, and in particular to forming and repairing wellbore casings to facilitate oil and gas exploration.

[004] During oil exploration, a wellbore typically traverses a number of zones within a subterranean formation. Wellbore casings are then formed in the wellbore by radially expanding and plastically deforming tubular members that are coupled to one another by threaded connections. Existing methods for radially expanding and plastically deforming tubular members coupled to one another by threaded connections are not always reliable or produce satisfactory results. In particular, the threaded connections can be damaged during the radial expansion process. Furthermore, the threaded connections between adjacent tubular members, whether radially expanded or not, are typically not sufficiently coupled to permit the transmission of energy through the tubular members from the surface to a downhole location.

[005] The present invention is directed to overcoming one or more of the limitations of the existing processes for radially expanding and plastically deforming tubular members coupled to one another by threaded connections.

Summary of the Invention

[006] According to one aspect of the present invention, a method is provided that includes coupling an end of a first tubular member to an end of a tubular sleeve, coupling an end of a second tubular member to another end of the tubular sleeve, coupling the ends of the first and second tubular members, and radially expanding and plastically deforming the first tubular member and the second tubular member.

[007] According to another aspect of the present invention, an apparatus is provided that includes a tubular sleeve, a first tubular member coupled to an end of the tubular sleeve, and a second tubular member coupled to another end of the tubular sleeve and the first tubular member.

[008] According to another aspect of the present invention, a method of extracting geothermal energy from a subterranean source of geothermal energy is provided that includes drilling a borehole that traverses the subterranean source of geothermal energy, positioning a first casing string within the borehole, radially expanding and plastically deforming the first casing string within the borehole, positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy, overlapping a portion of the second casing string with a portion of the first casing string, radially expanding and plastically deforming the second casing string within the borehole, and extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings.

[009] According to another aspect of the present invention, an apparatus for extracting geothermal energy from a subterranean source of geothermal energy is provided that includes a borehole that traverses the subterranean source of geothermal energy, a first casing string positioned within the borehole, and a second casing positioned within the borehole that overlaps with the first casing string that traverses the subterranean source of geothermal energy. The first casing string and the second casing string are radially expanded and plastically deformed within the borehole.

[0010] According to another aspect of the present invention, a method is provided that includes coupling an end of a first tubular member to an end of a tubular sleeve, coupling an end of a second tubular member to another end of the tubular sleeve, coupling the ends of the first and second tubular members, injecting a pressurized fluid through the first and second tubular members, determining if any of the pressurized fluid leaks through the coupled ends of the first and second tubular members, and if a predetermined amount of the pressurized fluid leaks through the coupled ends of the first and second tubular members, then coupling a tubular sleeve to the ends of the first and second tubular members and radially expanding and plastically deforming only the portions of the first and second tubular members proximate the tubular sleeve.

[0011] According to another aspect of the present invention, a method is provided that includes coupling an end of a first tubular member to an end of a tubular sleeve, coupling an end of a second tubular member to another end of the tubular sleeve, coupling the ends of the first and second tubular members, radially expanding and plastically deforming the first tubular member and the second tubular member, and transmitting energy through the first and second tubular members.

[0012] According to another aspect of the present invention, a system is provided that includes a source of energy, a borehole formed in the earth, a first tubular member positioned within the borehole operably coupled to the source of energy, a second tubular member positioned within the borehole coupled to the first tubular member, and a tubular sleeve positioned within the borehole coupled to the first and

second tubular members. The first tubular member, second tubular member, and the tubular sleeve are plastically deformed into engagement with one another.

[0013] According to another aspect of the present invention, a method of operating a well for extracting hydrocarbons from a subterranean formation is provided that includes drilling a borehole into the earth that traverses the subterranean formation, positioning a wellbore casing in the borehole, transmitting energy through the wellbore casing, and extracting hydrocarbons from the subterranean formation.

Brief Description of the Drawings

[0014] FIG. 1a is a fragmentary cross-sectional illustration of a first tubular member having an internally threaded connection at an end portion.

[0015] Fig. 1b is a fragmentary cross-sectional illustration of the placement of a tubular sleeve onto the end portion of the first tubular member of Fig. 1a.

[0016] Fig. 1c is a fragmentary cross-sectional illustration of the coupling of an externally threaded connection at an end portion of a second tubular member to the internally threaded connection at the end portion of the first tubular member of Fig. 1b.

[0017] Fig. 1d is a fragmentary cross-sectional illustration of the radial expansion and plastic deformation of a portion of the first tubular member of Fig. 1c.

[0018] Fig. 1e is a fragmentary cross sectional of the continued radial expansion and plastic deformation of the threaded connection between the first and second tubular members and the tubular sleeve of Fig. 1d.

[0019] Fig. 2a is a fragmentary cross-sectional illustration of the radial expansion and plastic deformation of a portion of a first tubular member having an internally threaded connection at an end portion, an alternative embodiment of a tubular sleeve supported by the end portion of the first tubular member, and a second tubular member having an externally threaded portion coupled to the internally threaded portion of the first tubular member.

[0020] Fig. 2b is a fragmentary cross sectional of the continued radial expansion and plastic deformation of the threaded connection between the first and second tubular members and the tubular sleeve of Fig. 2a.

[0021] Fig. 3a is a fragmentary cross-sectional illustration of the radial expansion and plastic deformation of a portion of a first tubular member having an internally threaded connection at an end portion, an alternative embodiment of a tubular sleeve supported by the end portion of the first tubular member, and a second tubular member having an externally threaded portion coupled to the internally threaded portion of the first tubular member.

[0022] Fig. 3b is a fragmentary cross sectional of the continued radial expansion and plastic deformation of the threaded connection between the first and second tubular members and the tubular sleeve of Fig. 3a.

[0023] Fig. 4a is a fragmentary cross-sectional illustration of the radial expansion and plastic deformation of a portion of a first tubular member having an internally threaded connection at an end portion, an alternative embodiment of a tubular sleeve having an external sealing element supported by the end portion of the first tubular member, and a second tubular member having an externally threaded portion coupled to the internally threaded portion of the first tubular member.

[0024] Fig. 4b is a fragmentary cross sectional of the continued radial expansion and plastic deformation of the threaded connection between the first and second tubular members and the tubular sleeve of Fig. 4a.

[0025] Fig. 5a is a fragmentary cross-sectional illustration of the radial expansion and plastic deformation of a portion of a first tubular member having an internally threaded connection at an end portion, an alternative embodiment of a tubular sleeve supported by the end portion of the first tubular member, and a second tubular member having an externally threaded portion coupled to the internally threaded portion of the first tubular member.

[0026] Fig. 5b is a fragmentary cross sectional of the continued radial expansion and plastic deformation of the threaded connection between the first and second tubular members and the tubular sleeve of Fig. 5a.

[0027] Fig. 6a is a fragmentary cross sectional illustration of an alternative embodiment of a tubular sleeve.

[0028] Fig. 6b is a fragmentary cross sectional illustration of an alternative embodiment of a tubular sleeve.

[0029] Fig. 6c is a fragmentary cross sectional illustration of an alternative embodiment of a tubular sleeve.

[0030] Fig. 6d is a fragmentary cross sectional illustration of an alternative embodiment of a tubular sleeve.

[0031] FIG. 7a is a fragmentary cross-sectional illustration of a first tubular member having an internally threaded connection at an end portion.

[0032] Fig. 7b is a fragmentary cross-sectional illustration of the placement of an alternative embodiment of a tubular sleeve onto the end portion of the first tubular member of Fig. 7a.

[0033] Fig. 7c is a fragmentary cross-sectional illustration of the coupling of an externally threaded connection at an end portion of a second tubular member to the internally threaded connection at the end portion of the first tubular member of Fig. 7b.

[0034] Fig. 7d is a fragmentary cross-sectional illustration of the radial expansion and plastic deformation of a portion of the first tubular member of Fig. 1c.

[0035] Fig. 7e is a fragmentary cross sectional of the continued radial expansion and plastic deformation of the threaded connection between the first and second tubular members and the tubular sleeve of Fig. 7d.

[0036] FIG. 8a is a fragmentary cross-sectional illustration of a first tubular member having an internally threaded connection at an end portion.

[0037] Fig. 8b is a fragmentary cross-sectional illustration of the placement of an alternative embodiment of a tubular sleeve onto the end portion of the first tubular member of Fig. 8a.

[0038] Fig. 8c is a fragmentary cross-sectional illustration of the coupling of the tubular sleeve of Fig. 8b to the end portion of the first tubular member.

[0039] Fig. 8d is a fragmentary cross-sectional illustration of the coupling of an externally threaded connection at an end portion of a second tubular member to the internally threaded connection at the end portion of the first tubular member of Fig. 8b.

[0040] Fig. 8e is a fragmentary cross-sectional illustration of the coupling of the tubular sleeve of Fig. 8d to the end portion of the second tubular member.

[0041] Fig. 8f is a fragmentary cross-sectional illustration of the radial expansion and plastic deformation of a portion of the first tubular member of Fig. 8e.

[0042] Fig. 8g is a fragmentary cross sectional of the continued radial expansion and plastic deformation of the threaded connection between the first and second tubular members and the tubular sleeve of Fig. 8f.

[0043] FIG. 9a is a fragmentary cross-sectional illustration of a first tubular member having an internally threaded connection at an end portion.

[0044] Fig. 9b is a fragmentary cross-sectional illustration of the placement of an alternative embodiment of a tubular sleeve onto the end portion of the first tubular member of Fig. 9a.

[0045] Fig. 9c is a fragmentary cross-sectional illustration of the coupling of an externally threaded connection at an end portion of a second tubular member to the internally threaded connection at the end portion of the first tubular member of Fig. 9b.

[0046] Fig. 9d is a fragmentary cross-sectional illustration of the radial expansion and plastic deformation of a portion of the first tubular member of Fig. 9c.

[0047] Fig. 9e is a fragmentary cross sectional of the continued radial expansion and plastic deformation of the threaded connection between the first and second tubular members and the tubular sleeve of Fig. 9d.

[0048] FIG. 10a is a fragmentary cross-sectional illustration of a first tubular member having an internally threaded connection at an end portion.

[0049] Fig. 10b is a fragmentary cross-sectional illustration of the placement of an alternative embodiment of a tubular sleeve onto the end portion of the first tubular member of Fig. 10a.

[0050] Fig. 10c is a fragmentary cross-sectional illustration of the coupling of an externally threaded connection at an end portion of a second tubular member to the internally threaded connection at the end portion of the first tubular member of Fig. 10b.

[0051] Fig. 10d is a fragmentary cross-sectional illustration of the radial expansion and plastic deformation of a portion of the first tubular member of Fig. 10c.

[0052] Fig. 10e is a fragmentary cross sectional of the continued radial expansion and plastic deformation of the threaded connection between the first and second tubular members and the tubular sleeve of Fig. 10d.

[0053] FIG. 11a is a fragmentary cross-sectional illustration of a first tubular member having an internally threaded connection at an end portion.

[0054] Fig. 11b is a fragmentary cross-sectional illustration of the placement of an alternative embodiment of a tubular sleeve onto the end portion of the first tubular member of Fig. 11a.

[0055] Fig. 11c is a fragmentary cross-sectional illustration of the coupling of an externally threaded connection at an end portion of a second tubular member to the internally threaded connection at the end portion of the first tubular member of Fig. 11b.

[0056] Fig. 11d is a fragmentary cross-sectional illustration of the radial expansion and plastic deformation of a portion of the first tubular member of Fig. 11c.

[0057] Fig. 11e is a fragmentary cross sectional of the continued radial expansion and plastic deformation of the threaded connection between the first and second tubular members and the tubular sleeve of Fig. 11d.

[0058] FIG. 12a is a fragmentary cross-sectional illustration of a first tubular member having an internally threaded connection at an end portion.

[0059] Fig. 12b is a fragmentary cross-sectional illustration of the placement of an alternative embodiment of a tubular sleeve onto the end portion of the first tubular member of Fig. 12a.

[0060] Fig. 12c is a fragmentary cross-sectional illustration of the coupling of an externally threaded connection at an end portion of a second tubular member to the internally threaded connection at the end portion of the first tubular member of Fig. 12b.

[0061] Fig. 12d is a fragmentary cross-sectional illustration of the radial expansion and plastic deformation of a portion of the first tubular member of Fig. 12c.

[0062] Fig. 12e is a fragmentary cross sectional of the continued radial expansion and plastic deformation of the threaded connection between the first and second tubular members and the tubular sleeve of Fig. 12d.

[0063] Fig. 13a is a fragmentary cross-sectional illustration of the coupling of an end portion of an alternative embodiment of a tubular sleeve onto the end portion of a first tubular member.

[0064] Fig. 13b is a fragmentary cross-sectional illustration of the coupling of an end portion of a second tubular member to the other end portion of the tubular sleeve of Fig. 13a.

[0065] Fig. 13c is a fragmentary cross-sectional illustration of the radial expansion and plastic deformation of a portion of the first tubular member of Fig. 13b.

[0066] Fig. 13d is a fragmentary cross sectional of the continued radial expansion and plastic deformation of the threaded connection between the first and second tubular members and the tubular sleeve of Fig. 13c.

[0067] FIG. 14a is a fragmentary cross-sectional illustration of an end portion of a first tubular member.

[0068] Fig. 14b is a fragmentary cross-sectional illustration of the coupling of an end portion of an alternative embodiment of a tubular sleeve onto the end portion of the first tubular member of Fig. 14a.

[0069] Fig. 14c is a fragmentary cross-sectional illustration of the coupling of an end portion of a second tubular member to the other end portion of the tubular sleeve of Fig. 14b.

[0070] Fig. 14d is a fragmentary cross-sectional illustration of the radial expansion and plastic deformation of a portion of the first tubular member of Fig. 14c.

[0071] Fig. 14e is a fragmentary cross sectional of the continued radial expansion and plastic deformation of the threaded connection between the first and second tubular members and the tubular sleeve of Fig. 14d.

[0072] Fig. 15a is a fragmentary cross-sectional illustration of the coupling of an internally threaded end portion of a first tubular member to an externally threaded end portion of a second tubular member including a protective sleeve coupled to the end portions of the first and second tubular member.

[0073] Fig. 15b is a cross-sectional illustration of the first and second tubular members and the protective sleeve following the radial expansion of the first and second tubulars and the protective sleeve.

[0074] Fig. 15c is a fragmentary cross-sectional illustration of an alternative embodiment that includes a metallic foil for amorphously bonding the first and second tubular members of Figs. 15a and 15b during the radial expansion and plastic deformation of the tubular members.

[0075] Fig. 16 is a cross-sectional illustration of a borehole including a plurality of overlapping radially expanded wellbore casings that traverses a subterranean source of geothermal energy.

[0076] Fig. 17a is a fragmentary cross-sectional illustration of the coupling of an internally threaded end portion of a first tubular member to an externally threaded end portion of a second tubular member including a protective sleeve coupled to the end portions of the first and second tubular member.

[0077] Fig. 17b is a fragmentary cross-sectional illustration of the radial expansion and plastic deformation of the threaded portions of the first and second tubular members using an adjustable expansion cone.

[0078] Fig. 17c is an enlarged fragmentary cross-sectional illustration of the threaded portions of the first and second tubular members and the protective sleeve prior to the radial expansion and plastic deformation of the threaded portions.

[0079] Fig. 17d is an enlarged fragmentary cross-sectional illustration of the threaded portions of the first and second tubular members and the protective sleeve after the radial expansion and plastic deformation of the threaded portions.

[0080] Fig. 18a is a fragmentary cross-sectional illustration of the coupling of an internally threaded end portion of a first tubular member to an externally threaded end portion of a second tubular member including a protective sleeve coupled to the end portions of the first and second tubular member.

[0081] Fig. 18b is a fragmentary cross-sectional illustration of the radial expansion and plastic deformation of the threaded portions of the first and second tubular members using a rotary expansion tool.

[0082] Fig. 19 is an exemplary embodiment of a method of providing a fluid tight seal in the junction between a pair of adjacent tubular members.

[0083] Fig. 20 is an exemplary embodiment of a method of transmitting energy through a pair of radially expanded adjacent tubular members including a protecting sleeve.

Detailed Description of the Illustrative Embodiments

[0084] Referring to Fig. 1a, a first tubular member 10 includes an internally threaded connection 12 at an end portion 14. As illustrated in Fig. 1b, a first end of a tubular sleeve 16 that includes an internal flange 18 and tapered portions, 20 and 22, at opposite ends is then mounted upon and receives the end portion 14 of the first tubular member 10. In an exemplary embodiment, the end portion 14 of the first tubular member 10 abuts one side of the internal flange 18 of the tubular sleeve 16, and the internal diameter of the internal flange of the tubular sleeve is substantially equal to or greater than the maximum internal diameter of the internally threaded connection 12 of the end portion of the first tubular member. As illustrated in Fig. 1c, an externally threaded connection 24 of an end portion 26 of a second tubular member 28 having an annular recess 30 is then positioned within the tubular sleeve 16 and threadably coupled to the internally threaded connection 12 of the end portion 14 of the first tubular member 10. In an exemplary embodiment, the internal flange 18 of the tubular sleeve 16 mates with and is received within the annular recess 30 of the end portion 26 of the second tubular member 28. Thus, the tubular sleeve 16 is coupled to and surrounds the external surfaces of the first and second tubular members, 10 and 28.

[0085] In an exemplary embodiment, the internally threaded connection 12 of the end portion 14 of the first tubular member 10 is a box connection, and the externally threaded connection 24 of the end portion 26 of the second tubular member 28 is a pin connection. In an exemplary embodiment, the internal diameter of the tubular sleeve 16 is at least approximately .020" greater than the outside diameters of the first and second tubular members, 10 and 28. In this manner, during the threaded coupling of the first and second tubular members, 10 and 28, fluidic materials within the first and second tubular members may be vented from the tubular members.

[0086] In an exemplary embodiment, as illustrated in Figs. 1d and 1e, the first and second tubular members, 10 and 28, and the tubular sleeve 16 may then be positioned within another structure 32 such as, for example, a wellbore, and radially expanded and plastically deformed, for example, by moving an expansion cone 34 through the interiors of the first and second tubular members. The tapered portions, 20 and 22, of the tubular sleeve 16 facilitate the insertion and movement of the first

and second tubular members within and through the structure 32, and the movement of the expansion cone 34 through the interiors of the first and second tubular members, 10 and 28, may be from top to bottom or from bottom to top.

[0087] In an exemplary embodiment, during the radial expansion and plastic deformation of the first and second tubular members, 10 and 28, the tubular sleeve 16 is also radially expanded and plastically deformed. In an exemplary embodiment, as a result, the tubular sleeve 16 may be maintained in circumferential tension and the end portions, 14 and 26, of the first and second tubular members, 10 and 28, may be maintained in circumferential compression.

[0088] In several exemplary embodiments, the first and second tubular members, 10 and 28, are radially expanded and plastically deformed using the expansion cone 34 in a conventional manner and/or using one or more of the methods and apparatus disclosed in one or more of the following: (1) U.S. patent application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, (3) U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, (4) U.S. patent application serial no. 09/440,338, attorney docket no. 25791.9.02, filed on 11/15/1999, (5) U.S. patent application serial no. 09/523,460, attorney docket no. 25791.11.02, filed on 3/10/2000, (6) U.S. patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, (7) U.S. patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on 2/24/2000, (8) U.S. patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, (9) U.S. patent application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, (10) PCT patent application serial no. PCT/US00/18635, attorney docket no. 25791.25.02, filed on 7/9/2000, (11) U.S. provisional patent application serial no. 60/162,671, attorney docket no. 25791.27, filed on 11/1/1999, (12) U.S. provisional patent application serial no. 60/154,047, attorney docket no. 25791.29, filed on 9/16/1999, (13) U.S. provisional patent application serial no. 60/159,082, attorney docket no. 25791.34, filed on 10/12/1999, (14) U.S. provisional patent application serial no. 60/159,039, attorney docket no. 25791.36, filed on 10/12/1999, (15) U.S. provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (16) U.S. provisional patent application serial no. 60/212,359, attorney docket no. 25791.38, filed on 6/19/2000, (17) U.S. provisional patent application serial no. 60/165,228, attorney docket no. 25791.39, filed on 11/12/1999, (18) U.S. provisional patent application serial no. 60/221,443, attorney docket no. 25791.45, filed on 7/28/2000, (19) U.S. provisional patent application serial no. 60/221,645, attorney docket no. 25791.46, filed on 7/28/2000, (20) U.S. provisional patent application serial no. 60/233,638, attorney docket no. 25791.47, filed on 9/18/2000, (21) U.S. provisional patent application serial no. 60/237,334, attorney docket no. 25791.48, filed on 10/2/2000, (22) U.S. provisional patent application serial no. 60/270,007, attorney docket no. 25791.50, filed on 2/20/2001, (23) U.S. provisional patent application serial no. 60/262,434, attorney docket no. 25791.51, filed on 1/17/2001,

(24) U.S, provisional patent application serial no. 60/259,486, attorney docket no. 25791.52, filed on 1/3/2001, (25) U.S. provisional patent application serial no. 60/303,740, attorney docket no. 25791.61, filed on 7/6/2001, (26) U.S. provisional patent application serial no. 60/313,453, attorney docket no. 25791.59, filed on 8/20/2001, (27) U.S. provisional patent application serial no. 60/317,985, attorney docket no. 25791.67, filed on 9/6/2001, (28) U.S. provisional patent application serial no. 60/3318,386, attorney docket no. 25791.67.02, filed on 9/10/2001, (29) U.S. utility patent application serial no. 09/969,922, attorney docket no. 25791.69, filed on 10/3/2001, (30) U.S. utility patent application serial no. 10/016,467, attorney docket no. 25791.70, filed on 12/10/2001; (31) U.S. provisional patent application serial no. 60/343,674, attorney docket no. 25791.68, filed on 12/27/2001; (32) U.S. provisional patent application serial no. 60/346,309, attorney docket no 25791.92, filed on 1/7/2002; (33) U.S. provisional patent application serial no. 60/372,048, attorney docket no. 25791.93, filed on 4/12/2002; (34) U.S. provisional patent application serial no. 60/380,147, attorney docket no. 25791.104, filed on 5/6/2002; (35) U.S. provisional patent application serial no. 60/387,486, attorney docket no. 25791.107, filed on 6/10/2002; (36) U.S. provisional patent application serial no. 60/387,961, attorney docket no. 25791.108, filed on 6/12/2002; and (37) U.S. provisional patent application serial no. 60/391,703, attorney docket no. 25791.90, filed on 6/26/2002, the disclosures of which are incorporated herein by reference.

[0089] In several alternative embodiments, the first and second tubular members, 10 and 28, are radially expanded and plastically deformed using other conventional methods for radially expanding and plastically deforming tubular members such as, for example, internal pressurization and/or roller expansion devices such as, for example, that disclosed in U.S. patent application publication no. US 2001/0045284 A1, the disclosure of which is incorporated herein by reference.

[0090] The use of the tubular sleeve 16 during (a) the coupling of the first tubular member 10 to the second tubular member 28, (b) the placement of the first and second tubular members in the structure 32, and (c) the radial expansion and plastic deformation of the first and second tubular members provides a number of significant benefits. For example, the tubular sleeve 16 protects the exterior surfaces of the end portions, 14 and 26, of the first and second tubular members, 10 and 28, during handling and insertion of the tubular members within the structure 32. In this manner, damage to the exterior surfaces of the end portions, 14 and 26, of the first and second tubular member, 10 and 28, are prevented that could result in stress concentrations that could result in a catastrophic failure during subsequent radial expansion operations. Furthermore, the tubular sleeve 16 provides an alignment guide that facilitates the insertion and threaded coupling of the second tubular member 28 to the first tubular member 10. In this manner, misalignment that could result in damage to the threaded connections, 12 and 24, of the first and second tubular members, 10 and 28, may be avoided. In addition, during the relative rotation of the second tubular member with respect to the first tubular member, required during the threaded coupling of the first and second tubular members, the tubular

sleeve 16 provides an indication of to what degree the first and second tubular members are threadably coupled. For example, if the tubular sleeve 16 can be easily rotated, that would indicate that the first and second tubular members, 10 and 28, are not fully threadably coupled and in intimate contact with the internal flange 18 of the tubular sleeve. Furthermore, the tubular sleeve 16 may prevent crack propagation during the radial expansion and plastic deformation of the first and second tubular members, 10 and 28. In this manner, failure modes such as, for example, longitudinal cracks in the end portions, 14 and 26, of the first and second tubular members may be limited in severity or eliminated all together. In addition, after completing the radial expansion and plastic deformation of the first and second tubular members, 10 and 28, the tubular sleeve 16 may provide a fluid tight metal-to-metal seal between interior surface of the tubular sleeve and the exterior surfaces of the end portions, 14 and 26, of the first and second tubular members. In this manner, fluidic materials are prevented from passing through the threaded connections, 12 and 24, of the first and second tubular members, 10 and 28, into the annulus between the first and second tubular members and the structure 32. Furthermore, because, following the radial expansion and plastic deformation of the first and second tubular members, 10 and 28, the tubular sleeve 16 may be maintained in circumferential tension and the end portions, 14 and 26, of the first and second tubular members, 10 and 28, may be maintained in circumferential compression, axial loads and/or torque loads may be transmitted through the tubular sleeve. In addition, the tubular sleeve 16 may also increase the collapse strength of the end portions, 14 and 26, of the first and second tubular members, 10 and 28.

[0091] Referring to Figs. 2a and 2b, in an alternative embodiment, a tubular sleeve 110 having an internal flange 112 and a tapered portion 114 is coupled to the first and second tubular members, 10 and 28. In particular, the tubular sleeve 110 receives and mates with the end portion 14 of the first tubular member 10, and the internal flange 112 of the tubular sleeve is received within the annular recess 30 of the second tubular member 28 proximate the end of the first tubular member. In this manner, the tubular sleeve 110 is coupled to the end portions, 14 and 26, of the first and second tubular members, 10 and 28, and the tubular sleeve covers the end portion 14 of the first tubular member 10.

[0092] In an exemplary embodiment, the first and second tubular members, 10 and 28, and the tubular sleeve 110 may then be positioned within the structure 32 and radially expanded and plastically deformed, for example, by moving an expansion cone 34 through the interiors of the first and second tubular members. In an exemplary embodiment, following the radial expansion and plastic deformation of the first and second tubular members, 10 and 28, the tubular sleeve 110 may be maintained in circumferential tension and the end portions, 14 and 26, of the first and second tubular members, 10 and 28, may be maintained in circumferential compression.

[0093] The use of the tubular sleeve 110 during (a) the coupling of the first tubular member 10 to the second tubular member 28, (b) the placement of the first and second tubular members in the structure 32, and (c) the radial expansion and plastic deformation of the first and second tubular

members provides a number of significant benefits. For example, the tubular sleeve 110 protects the exterior surface of the end portion 14 of the first tubular member 10 during handling and insertion of the tubular members within the structure 32. In this manner, damage to the exterior surfaces of the end portion 14 of the first tubular member 10 is prevented that could result in stress concentrations that could result in a catastrophic failure during subsequent radial expansion operations. In addition, during the relative rotation of the second tubular member with respect to the first tubular member, required during the threaded coupling of the first and second tubular members, the tubular sleeve 110 provides an indication of to what degree the first and second tubular members are threadably coupled. For example, if the tubular sleeve 110 can be easily rotated, that would indicate that the first and second tubular members, 10 and 28, are not fully threadably coupled and in intimate contact with the internal flange 112 of the tubular sleeve. Furthermore, the tubular sleeve 110 may prevent crack propagation during the radial expansion and plastic deformation of the first and second tubular members, 10 and 28. In this manner, failure modes such as, for example, longitudinal cracks in the end portions, 14 and 26, of the first and second tubular members may be limited in severity or eliminated all together. In addition, after completing the radial expansion and plastic deformation of the first and second tubular members, 10 and 28, the tubular sleeve 110 may provide a fluid tight metal-to-metal seal between interior surface of the tubular sleeve and the exterior surface of the end portion14 of the first tubular member. In this manner, fluidic materials are prevented from passing through the threaded connections, 12 and 24, of the first and second tubular members, 10 and 28, into the annulus between the first and second tubular members and the structure 32. Furthermore, because, following the radial expansion and plastic deformation of the first and second tubular members, 10 and 28, the tubular sleeve 110 may be maintained in circumferential tension and the end portions, 14 and 26, of the first and second tubular members, 10 and 28, may be maintained in circumferential compression, axial loads and/or torque loads may be transmitted through the tubular sleeve.

[0094] Referring to Figs. 3a and 3b, in an alternative embodiment, a tubular sleeve 210 having an internal flange 212, tapered portions, 214 and 216, at opposite ends, and annular sealing members, 218 and 220, positioned on opposite sides of the internal flange, is coupled to the first and second tubular members, 10 and 28. In particular, the tubular sleeve 210 receives and mates with the end portions, 14 and 26, of the first and second tubular members, 10 and 28, and the internal flange 212 of the tubular sleeve is received within the annular recess 30 of the second tubular member 28 proximate the end of the first tubular member. Furthermore, the sealing members, 218 and 220, of the tubular sleeve 210 engage and fluidicly seal the interface between the tubular sleeve and the end portions, 14 and 26, of the first and second tubular members, 10 and 28. In this manner, the tubular sleeve 210 is coupled to the end portions, 14 and 26, of the first and second tubular members, 10 and 28, and the tubular sleeve covers the end portions, 14 and 26, of the first and second tubular members, 10 and 28.

[0095] In an exemplary embodiment, the first and second tubular members, 10 and 28, and the

tubular sleeve 210 may then be positioned within the structure 32 and radially expanded and plastically deformed, for example, by moving an expansion cone 34 through the interiors of the first and second tubular members. In an exemplary embodiment, following the radial expansion and plastic deformation of the first and second tubular members, 10 and 28, the tubular sleeve 210 may be maintained in circumferential tension and the end portions, 14 and 26, of the first and second tubular members, 10 and 28, may be maintained in circumferential compression.

[0096] The use of the tubular sleeve 210 during (a) the coupling of the first tubular member 10 to the second tubular member 28, (b) the placement of the first and second tubular members in the structure 32, and (c) the radial expansion and plastic deformation of the first and second tubular members provides a number of significant benefits. For example, the tubular sleeve 210 protects the exterior surfaces of the end portions, 14 and 26, of the first and second tubular members, 10 and 28, during handling and insertion of the tubular members within the structure 32. In this manner, damage to the exterior surfaces of the end portions, 14 and 26, of the first and second tubular members, 10 and 28, is prevented that could result in stress concentrations that could result in a catastrophic failure during subsequent radial expansion operations. In addition, during the relative rotation of the second tubular member with respect to the first tubular member, required during the threaded coupling of the first and second tubular members, the tubular sleeve 210 provides an indication of to what degree the first and second tubular members are threadably coupled. For example, if the tubular sleeve 210 can be easily rotated, that would indicate that the first and second tubular members, 10 and 28, are not fully threadably coupled and in intimate contact with the internal flange 212 of the tubular sleeve. Furthermore, the tubular sleeve 210 may prevent crack propagation during the radial expansion and plastic deformation of the first and second tubular members, 10 and 28. In this manner, failure modes such as, for example, longitudinal cracks in the end portions, 14 and 26, of the first and second tubular members, 10 and 28, may be limited in severity or eliminated all together. In addition, after completing the radial expansion and plastic deformation of the first and second tubular members, 10 and 28, the tubular sleeve 210 may provide a fluid tight metal-to-metal seal between interior surface of the tubular sleeve and the exterior surfaces of the end portions,14 and 26, of the first and second tubular members. In this manner, fluidic materials are prevented from passing through the threaded connections, 12 and 24, of the first and second tubular members, 10 and 28, into the annulus between the first and second tubular members and the structure 32. Furthermore, because, following the radial expansion and plastic deformation of the first and second tubular members, 10 and 28, the tubular sleeve 210 may be maintained in circumferential tension and the end portions, 14 and 26, of the first and second tubular members, 10 and 28, may be maintained in circumferential compression, axial loads and/or torque loads may be transmitted through the tubular sleeve. In addition, the tubular sleeve 210 may also increase the collapse strength of the end portions, 14 and 26, of the first and second tubular members, 10 and 28.

[0097] Referring to Figs. 4a and 4b, in an alternative embodiment, a tubular sleeve 310 having an internal flange 312, tapered portions, 314 and 316, at opposite ends, and an annular sealing member 318 positioned on the exterior surface of the tubular sleeve, is coupled to the first and second tubular members, 10 and 28. In particular, the tubular sleeve 310 receives and mates with the end portions, 14 and 26, of the first and second tubular members, 10 and 28, and the internal flange 312 of the tubular sleeve is received within the annular recess 30 of the second tubular member 28 proximate the end of the first tubular member. In this manner, the tubular sleeve 310 is coupled to the end portions, 14 and 26, of the first and second tubular members, 10 and 28, and the tubular sleeve covers the end portions, 14 and 26, of the first and second tubular members, 10 and 28.

[0098] In an exemplary embodiment, the first and second tubular members, 10 and 28, and the tubular sleeve 310 may then be positioned within the structure 32 and radially expanded and plastically deformed, for example, by moving an expansion cone 34 through the interiors of the first and second tubular members. In an exemplary embodiment, following the radial expansion and plastic deformation of the first and second tubular members, 10 and 28, the tubular sleeve 310 may be maintained in circumferential tension and the end portions, 14 and 26, of the first and second tubular members, 10 and 28, may be maintained in circumferential compression. Furthermore, in an exemplary embodiment, following the radial expansion and plastic deformation of the first and second tubular members, 10 and 28, the annular sealing member 318 circumferentially engages the interior surface of the structure 32 thereby preventing the passage of fluidic materials through the annulus between the tubular sleeve 310 and the structure. In this manner, the tubular sleeve 310 may provide an expandable packer element.

[0099] The use of the tubular sleeve 310 during (a) the coupling of the first tubular member 10 to the second tubular member 28, (b) the placement of the first and second tubular members in the structure 32, and (c) the radial expansion and plastic deformation of the first and second tubular members provides a number of significant benefits. For example, the tubular sleeve 310 protects the exterior surfaces of the end portions, 14 and 26, of the first and second tubular members, 10 and 28, during handling and insertion of the tubular members within the structure 32. In this manner, damage to the exterior surfaces of the end portions, 14 and 26, of the first and second tubular members, 10 and 28, is prevented that could result in stress concentrations that could result in a catastrophic failure during subsequent radial expansion operations. In addition, during the relative rotation of the second tubular member with respect to the first tubular member, required during the threaded coupling of the first and second tubular members, the tubular sleeve 310 provides an indication of to what degree the first and second tubular members are threadably coupled. For example, if the tubular sleeve 310 can be easily rotated, that would indicate that the first and second tubular members, 10 and 28, are not fully threadably coupled and in intimate contact with the internal flange 312 of the tubular sleeve. Furthermore, the tubular sleeve 310 may prevent crack propagation during the radial expansion and

plastic deformation of the first and second tubular members, 10 and 28. In this manner, failure modes such as, for example, longitudinal cracks in the end portions, 14 and 26, of the first and second tubular members, 10 and 28, may be limited in severity or eliminated all together. In addition, after completing the radial expansion and plastic deformation of the first and second tubular members, 10 and 28, the tubular sleeve 310 may provide a fluid tight metal-to-metal seal between interior surface of the tubular sleeve and the exterior surfaces of the end portions,14 and 26, of the first and second tubular members. In this manner, fluidic materials are prevented from passing through the threaded connections, 12 and 24, of the first and second tubular members, 10 and 28, into the annulus between the first and second tubular members and the structure 32. Furthermore, because, following the radial expansion and plastic deformation of the first and second tubular members, 10 and 28, the tubular sleeve 310 may be maintained in circumferential tension and the end portions, 14 and 26, of the first and second tubular members, 10 and 28, may be maintained in circumferential compression, axial loads and/or torque loads may be transmitted through the tubular sleeve. In addition, because, following the radial expansion and plastic deformation of the first and second tubular members, 10 and 28, the annular sealing member 318 may circumferentially engage the interior surface of the structure 32, the tubular sleeve 310 may provide an expandable packer element. In addition, the tubular sleeve 318 may also increase the collapse strength of the end portions, 14 and 26, of the first and second tubular members, 10 and 28.

[00100] Referring to Figs. 5a and 5b, in an alternative embodiment, a non-metallic tubular sleeve 410 having an internal flange 412, and tapered portions, 414 and 416, at opposite ends, is coupled to the first and second tubular members, 10 and 28. In particular, the tubular sleeve 410 receives and mates with the end portions, 14 and 26, of the first and second tubular members, 10 and 28, and the internal flange 412 of the tubular sleeve is received within the annular recess 30 of the second tubular member 28 proximate the end of the first tubular member. In this manner, the tubular sleeve 410 is coupled to the end portions, 14 and 26, of the first and second tubular members, 10 and 28, and the tubular sleeve covers the end portions, 14 and 26, of the first and second tubular members, 10 and 28.

[00101] In several exemplary embodiments, the tubular sleeve 410 may be plastic, ceramic, elastomeric, composite and/or a frangible material.

[00102] In an exemplary embodiment, the first and second tubular members, 10 and 28, and the tubular sleeve 410 may then be positioned within the structure 32 and radially expanded and plastically deformed, for example, by moving an expansion cone 34 through the interiors of the first and second tubular members. In an exemplary embodiment, following the radial expansion and plastic deformation of the first and second tubular members, 10 and 28, the tubular sleeve 410 may be maintained in circumferential tension and the end portions, 14 and 26, of the first and second tubular members, 10 and 28, may be maintained in circumferential compression. Furthermore, in an exemplary embodiment, during the radial expansion and plastic deformation of the first and second

tubular members, 10 and 28, the tubular sleeve 310 may be broken off of the first and second tubular members.

[00103] The use of the tubular sleeve 410 during (a) the coupling of the first tubular member 10 to the second tubular member 28, (b) the placement of the first and second tubular members in the structure 32, and (c) the radial expansion and plastic deformation of the first and second tubular members provides a number of significant benefits. For example, the tubular sleeve 410 protects the exterior surfaces of the end portions, 14 and 26, of the first and second tubular members, 10 and 28, during handling and insertion of the tubular members within the structure 32. In this manner, damage to the exterior surfaces of the end portions, 14 and 26, of the first and second tubular members, 10 and 28, is prevented that could result in stress concentrations that could result in a catastrophic failure during subsequent radial expansion operations. In addition, during the relative rotation of the second tubular member with respect to the first tubular member, required during the threaded coupling of the first and second tubular members, the tubular sleeve 410 provides an indication of to what degree the first and second tubular members are threadably coupled. For example, if the tubular sleeve 410 can be easily rotated, that would indicate that the first and second tubular members, 10 and 28, are not fully threadably coupled and in intimate contact with the internal flange 412 of the tubular sleeve. Furthermore, the tubular sleeve 410 may prevent crack propagation during the radial expansion and plastic deformation of the first and second tubular members, 10 and 28. In this manner, failure modes such as, for example, longitudinal cracks in the end portions, 14 and 26, of the first and second tubular members, 10 and 28, may be limited in severity or eliminated all together. In addition, after completing the radial expansion and plastic deformation of the first and second tubular members, 10 and 28, the tubular sleeve 410 may provide a fluid tight metal-to-metal seal between interior surface of the tubular sleeve and the exterior surfaces of the end portions,14 and 26, of the first and second tubular members. In this manner, fluidic materials are prevented from passing through the threaded connections, 12 and 24, of the first and second tubular members, 10 and 28, into the annulus between the first and second tubular members and the structure 32. Furthermore, because, following the radial expansion and plastic deformation of the first and second tubular members, 10 and 28, the tubular sleeve 410 may be maintained in circumferential tension and the end portions, 14 and 26, of the first and second tubular members, 10 and 28, may be maintained in circumferential compression, axial loads and/or torque loads may be transmitted through the tubular sleeve. In addition, because, during the radial expansion and plastic deformation of the first and second tubular members, 10 and 28, the tubular sleeve 410 may be broken off of the first and second tubular members, the final outside diameter of the first and second tubular members may more closely match the inside diameter of the structure 32. In addition, the tubular sleeve 410 may also increase the collapse strength of the end portions, 14 and 26, of the first and second tubular members, 10 and 28.

[00104] Referring to Fig. 6a, in an exemplary embodiment, a tubular sleeve 510 includes an

internal flange 512, tapered portions, 514 and 516, at opposite ends, and defines one or more axial slots 518. In an exemplary embodiment, during the radial expansion and plastic deformation of the first and second tubular members, 10 and 28, the axial slots 518 reduce the required radial expansion forces.

[00105] Referring to Fig. 6b, in an exemplary embodiment, a tubular sleeve 610 includes an internal flange 612, tapered portions, 614 and 616, at opposite ends, and defines one or more offset axial slots 618. In an exemplary embodiment, during the radial expansion and plastic deformation of the first and second tubular members, 10 and 28, the axial slots 618 reduce the required radial expansion forces.

[00106] Referring to Fig. 6c, in an exemplary embodiment, a tubular sleeve 710 includes an internal flange 712, tapered portions, 714 and 716, at opposite ends, and defines one or more radial openings 718. In an exemplary embodiment, during the radial expansion and plastic deformation of the first and second tubular members, 10 and 28, the radial openings 718 reduce the required radial expansion forces.

[00107] Referring to Fig. 6d, in an exemplary embodiment, a tubular sleeve 810 includes an internal flange 812, tapered portions, 814 and 816, at opposite ends, and defines one or more axial slots 818 that extend from the ends of the tubular sleeve. In an exemplary embodiment, during the radial expansion and plastic deformation of the first and second tubular members, 10 and 28, the axial slots 818 reduce the required radial expansion forces.

[00108] Referring to Fig. 7a, a first tubular member 910 includes an internally threaded connection 912 at an end portion 914 and a recessed portion 916 having a reduced outside diameter. As illustrated in Fig. 7b, a first end of a tubular sleeve 918 that includes annular sealing members, 920 and 922, at opposite ends, tapered portions, 924 and 926, at one end, and tapered portions, 928 and 930, at another end is then mounted upon and receives the end portion 914 of the first tubular member 910. In an exemplary embodiment, a resilient retaining ring 930 is positioned between the lower end of the tubular sleeve 918 and the recessed portion 916 of the first tubular member 910 in order to couple the tubular sleeve to the first tubular member. In an exemplary embodiment, the resilient retaining ring 930 is a split ring having a toothed surface in order to lock the tubular sleeve 918 in place.

[00109] As illustrated in Fig. 7c, an externally threaded connection 934 of an end portion 936 of a second tubular member 938 having a recessed portion 940 having a reduced outside diameter is then positioned within the tubular sleeve 918 and threadably coupled to the internally threaded connection 912 of the end portion 914 of the first tubular member 910. In an exemplary embodiment, a resilient retaining ring 942 is positioned between the upper end of the tubular sleeve 918 and the recessed portion 940 of the second tubular member 938 in order to couple the tubular sleeve to the second tubular member. In an exemplary embodiment, the resilient retaining ring 942 is a split ring having a toothed surface in order to lock the tubular sleeve 918 in place.

[00110] In an exemplary embodiment, the internally threaded connection 912 of the end portion

914 of the first tubular member 910 is a box connection, and the externally threaded connection 934 of the end portion 936 of the second tubular member 938 is a pin connection. In an exemplary embodiment, the internal diameter of the tubular sleeve 918 is at least approximately .020" greater than the outside diameters of the end portions, 914 and 936, of the first and second tubular members, 910 and 938. In this manner, during the threaded coupling of the first and second tubular members, 910 and 938, fluidic materials within the first and second tubular members may be vented from the tubular members.

[00111] In an exemplary embodiment, as illustrated in Figs. 7d and 7e, the first and second tubular members, 910 and 938, and the tubular sleeve 918 may then be positioned within another structure 32 such as, for example, a wellbore, and radially expanded and plastically deformed, for example, by moving an expansion cone 34 through the interiors of the first and second tubular members. The tapered portions, 924 and 928, of the tubular sleeve 918 facilitate the insertion and movement of the first and second tubular members within and through the structure 32, and the movement of the expansion cone 34 through the interiors of the first and second tubular members, 910 and 938, may be from top to bottom or from bottom to top.

[00112] In an exemplary embodiment, during the radial expansion and plastic deformation of the first and second tubular members, 910 and 938, the tubular sleeve 918 is also radially expanded and plastically deformed. In an exemplary embodiment, as a result, the tubular sleeve 918 may be maintained in circumferential tension and the end portions, 914 and 936, of the first and second tubular members, 910 and 938, may be maintained in circumferential compression.

[00113] The use of the tubular sleeve 918 during (a) the coupling of the first tubular member 910 to the second tubular member 938, (b) the placement of the first and second tubular members in the structure 32, and (c) the radial expansion and plastic deformation of the first and second tubular members provides a number of significant benefits. For example, the tubular sleeve 918 protects the exterior surfaces of the end portions, 914 and 936, of the first and second tubular members, 910 and 938, during handling and insertion of the tubular members within the structure 32. In this manner, damage to the exterior surfaces of the end portions, 914 and 936, of the first and second tubular member, 910 and 938, are prevented that could result in stress concentrations that could result in a catastrophic failure during subsequent radial expansion operations. Furthermore, the tubular sleeve 918 provides an alignment guide that facilitates the insertion and threaded coupling of the second tubular member 938 to the first tubular member 910. In this manner, misalignment that could result in damage to the threaded connections, 912 and 934, of the first and second tubular members, 910 and 938, may be avoided. Furthermore, the tubular sleeve 918 may prevent crack propagation during the radial expansion and plastic deformation of the first and second tubular members, 910 and 938. In this manner, failure modes such as, for example, longitudinal cracks in the end portions, 914 and 936, of the first and second tubular members may be limited in severity or eliminated all together. In addition,

after completing the radial expansion and plastic deformation of the first and second tubular members, 910 and 938, the tubular sleeve 918 may provide a fluid tight metal-to-metal seal between interior surface of the tubular sleeve and the exterior surfaces of the end portions, 914 and 936, of the first and second tubular members. In this manner, fluidic materials are prevented from passing through the threaded connections, 912 and 934, of the first and second tubular members, 910 and 938, into the annulus between the first and second tubular members and the structure 32. Furthermore, because, following the radial expansion and plastic deformation of the first and second tubular members, 910 and 938, the tubular sleeve 918 may be maintained in circumferential tension and the end portions, 914 and 936, of the first and second tubular members, 910 and 938, may be maintained in circumferential compression, axial loads and/or torque loads may be transmitted through the tubular sleeve. In addition, the annular sealing members, 920 and 922, of the tubular sleeve 918 may provide a fluid tight seal between the tubular sleeve and the end portions, 914 and 936, of the first and second tubular members, 910 and 938. Furthermore, the tubular sleeve 918 may also increase the collapse strength of the end portions, 914 and 936, of the first and second tubular members, 910 and 938.

[00114] Referring to Fig. 8a, a first tubular member 1010 includes an internally threaded connection 1012 at an end portion 1014 and a recessed portion 1016 having a reduced outside diameter. As illustrated in Fig. 8b, a first end of a tubular sleeve 1018 that includes annular sealing members, 1020 and 1022, at opposite ends, tapered portions, 1024 and 1026, at one end, and tapered portions, 1028 and 1030, at another end is then mounted upon and receives the end portion 1014 of the first tubular member 1010. In an exemplary embodiment, as illustrated in Fig. 8c, the end of the tubular sleeve 1018 is then crimped onto the recessed portion 1016 of the first tubular member 1010 in order to couple the tubular sleeve to the first tubular member.

[00115] As illustrated in Fig. 8d, an externally threaded connection 1032 of an end portion 1034 of a second tubular member 1036 having a recessed portion 1038 having a reduced external diameter is then positioned within the tubular sleeve 1018 and threadably coupled to the internally threaded connection 1012 of the end portion 1014 of the first tubular member 1010. In an exemplary embodiment, as illustrated in Fig. 8e, the other end of the tubular sleeve 1018 is then crimped into the recessed portion 1038 of the second tubular member 1036 in order to couple the tubular sleeve to the second tubular member.

[00116] In an exemplary embodiment, the internally threaded connection 1012 of the end portion 1014 of the first tubular member 1010 is a box connection, and the externally threaded connection 1032 of the end portion 1034 of the second tubular member 1036 is a pin connection. In an exemplary embodiment, the internal diameter of the tubular sleeve 1018 is at least approximately .020" greater than the outside diameters of the end portions, 1014 and 1034, of the first and second tubular members, 1010 and 1036. In this manner, during the threaded coupling of the first and second tubular members, 1010 and 1036, fluidic materials within the first and second tubular members may be vented from the

tubular members.

[00117] In an exemplary embodiment, as illustrated in Figs. 8f and 8g, the first and second tubular members, 1010 and 1036, and the tubular sleeve 1018 may then be positioned within another structure 32 such as, for example, a wellbore, and radially expanded and plastically deformed, for example, by moving an expansion cone 34 through the interiors of the first and second tubular members. The movement of the expansion cone 34 through the interiors of the first and second tubular members, 1010 and 1036, may be from top to bottom or from bottom to top.

[00118] In an exemplary embodiment, during the radial expansion and plastic deformation of the first and second tubular members, 1010 and 1036, the tubular sleeve 1018 is also radially expanded and plastically deformed. In an exemplary embodiment, as a result, the tubular sleeve 1018 may be maintained in circumferential tension and the end portions, 1014 and 1034, of the first and second tubular members, 1010 and 1036, may be maintained in circumferential compression.

[00119] The use of the tubular sleeve 1018 during (a) the coupling of the first tubular member 1010 to the second tubular member 1036, (b) the placement of the first and second tubular members in the structure 32, and (c) the radial expansion and plastic deformation of the first and second tubular members provides a number of significant benefits. For example, the tubular sleeve 1018 protects the exterior surfaces of the end portions, 1014 and 1034, of the first and second tubular members, 1010 and 1036, during handling and insertion of the tubular members within the structure 32. In this manner, damage to the exterior surfaces of the end portions, 1014 and 1034, of the first and second tubular members, 1010 and 1036, are prevented that could result in stress concentrations that could result in a catastrophic failure during subsequent radial expansion operations. Furthermore, the tubular sleeve 1018 provides an alignment guide that facilitates the insertion and threaded coupling of the second tubular member 1036 to the first tubular member 1010. In this manner, misalignment that could result in damage to the threaded connections, 1012 and 1032, of the first and second tubular members, 1010 and 1036, may be avoided. Furthermore, the tubular sleeve 1018 may prevent crack propagation during the radial expansion and plastic deformation of the first and second tubular members, 1010 and 1036. In this manner, failure modes such as, for example, longitudinal cracks in the end portions, 1014 and 1034, of the first and second tubular members may be limited in severity or eliminated all together. In addition, after completing the radial expansion and plastic deformation of the first and second tubular members, 1010 and 1036, the tubular sleeve 1018 may provide a fluid tight metal-to-metal seal between interior surface of the tubular sleeve and the exterior surfaces of the end portions, 1014 and 1034, of the first and second tubular members. In this manner, fluidic materials are prevented from passing through the threaded connections, 1012 and 1032, of the first and second tubular members, 1010 and 1036, into the annulus between the first and second tubular members and the structure 32. Furthermore, because, following the radial expansion and plastic deformation of the first and second tubular members, 1010 and 1036, the tubular sleeve 1018 may be maintained in

circumferential tension and the end portions, 1014 and 1034, of the first and second tubular members, 1010 and 1036, may be maintained in circumferential compression, axial loads and/or torque loads may be transmitted through the tubular sleeve. In addition, the annular sealing members, 1020 and 1022, of the tubular sleeve 1018 may provide a fluid tight seal between the tubular sleeve and the end portions, 1014 and 1034, of the first and second tubular members, 1010 and 1036. Furthermore, the tubular sleeve 1018 may also increase the collapse strength of the end portions, 1014 and 1034, of the first and second tubular members, 1010 and 1036.

[00120] Referring to Fig. 9a, a first tubular member 1110 includes an internally threaded connection 1112 at an end portion 1114. As illustrated in Fig. 9b, a first end of a tubular sleeve 1116 having tapered portions, 1118 and 1120, at opposite ends, is then mounted upon and receives the end portion 1114 of the first tubular member 1110. In an exemplary embodiment, a toothed resilient retaining ring 1122 is then attached to first tubular member 1010 below the end of the tubular sleeve 1116 in order to couple the tubular sleeve to the first tubular member.

[00121] As illustrated in Fig. 9c, an externally threaded connection 1124 of an end portion 1126 of a second tubular member 1128 is then positioned within the tubular sleeve 1116 and threadably coupled to the internally threaded connection 1112 of the end portion 1114 of the first tubular member 1110. In an exemplary embodiment, a toothed resilient retaining ring 1130 is then attached to second tubular member 1128 above the end of the tubular sleeve 1116 in order to couple the tubular sleeve to the second tubular member.

[00122] In an exemplary embodiment, the internally threaded connection 1112 of the end portion 1114 of the first tubular member 1110 is a box connection, and the externally threaded connection 1124 of the end portion 1126 of the second tubular member 1128 is a pin connection. In an exemplary embodiment, the internal diameter of the tubular sleeve 1116 is at least approximately .020" greater than the outside diameters of the end portions, 1114 and 1126, of the first and second tubular members, 1110 and 1128. In this manner, during the threaded coupling of the first and second tubular members, 1110 and 1128, fluidic materials within the first and second tubular members may be vented from the tubular members.

[00123] In an exemplary embodiment, as illustrated in Figs. 9d and 9e, the first and second tubular members, 1110 and 1128, and the tubular sleeve 1116 may then be positioned within another structure 32 such as, for example, a wellbore, and radially expanded and plastically deformed, for example, by moving an expansion cone 34 through the interiors of the first and second tubular members. The movement of the expansion cone 34 through the interiors of the first and second tubular members, 1110 and 1128, may be from top to bottom or from bottom to top.

[00124] In an exemplary embodiment, during the radial expansion and plastic deformation of the first and second tubular members, 1110 and 1128, the tubular sleeve 1116 is also radially expanded and plastically deformed. In an exemplary embodiment, as a result, the tubular sleeve 1116 may be

maintained in circumferential tension and the end portions, 1114 and 1126, of the first and second tubular members, 1110 and 1128, may be maintained in circumferential compression.

[00125] The use of the tubular sleeve 1116 during (a) the coupling of the first tubular member 1110 to the second tubular member 1128, (b) the placement of the first and second tubular members in the structure 32, and (c) the radial expansion and plastic deformation of the first and second tubular members provides a number of significant benefits. For example, the tubular sleeve 1116 protects the exterior surfaces of the end portions, 1114 and 1126, of the first and second tubular members, 1110 and 1128, during handling and insertion of the tubular members within the structure 32. In this manner, damage to the exterior surfaces of the end portions, 1114 and 1126, of the first and second tubular members, 1110 and 1128, are prevented that could result in stress concentrations that could result in a catastrophic failure during subsequent radial expansion operations. Furthermore, the tubular sleeve 1116 provides an alignment guide that facilitates the insertion and threaded coupling of the second tubular member 1128 to the first tubular member 1110. In this manner, misalignment that could result in damage to the threaded connections, 1112 and 1124, of the first and second tubular members, 1110 and 1128, may be avoided. Furthermore, the tubular sleeve 1116 may prevent crack propagation during the radial expansion and plastic deformation of the first and second tubular members, 1110 and 1128. In this manner, failure modes such as, for example, longitudinal cracks in the end portions, 1114 and 1126, of the first and second tubular members may be limited in severity or eliminated all together. In addition, after completing the radial expansion and plastic deformation of the first and second tubular members, 1110 and 1128, the tubular sleeve 1116 may provide a fluid tight metal-to-metal seal between interior surface of the tubular sleeve and the exterior surfaces of the end portions, 1114 and 1128, of the first and second tubular members. In this manner, fluidic materials are prevented from passing through the threaded connections, 1112 and 1124, of the first and second tubular members, 1110 and 1128, into the annulus between the first and second tubular members and the structure 32. Furthermore, because, following the radial expansion and plastic deformation of the first and second tubular members, 1110 and 1128, the tubular sleeve 1116 may be maintained in circumferential tension and the end portions, 1114 and 1126, of the first and second tubular members, 1110 and 1128, may be maintained in circumferential compression, axial loads and/or torque loads may be transmitted through the tubular sleeve. In addition, the tubular sleeve 1116 may also increase the collapse strength of the end portions, 1114 and 1126, of the first and second tubular members.

[00126] Referring to Fig. 10a, a first tubular member 1210 includes an internally threaded connection 1212 at an end portion 1214. As illustrated in Fig. 10b, a first end of a tubular sleeve 1216 having tapered portions, 1218 and 1220, at one end and tapered portions, 1222 and 1224, at another end, is then mounted upon and receives the end portion 1114 of the first tubular member 1110. In an exemplary embodiment, a resilient elastomeric O-ring 1226 is then positioned on the first tubular member 1210 below the tapered portion 1224 of the tubular sleeve 1216 in order to couple the tubular

sleeve to the first tubular member.

[00127] As illustrated in Fig. 10c, an externally threaded connection 1228 of an end portion 1230 of a second tubular member 1232 is then positioned within the tubular sleeve 1216 and threadably coupled to the internally threaded connection 1212 of the end portion 1214 of the first tubular member 1210. In an exemplary embodiment, a resilient elastomeric O-ring 1234 is then positioned on the second tubular member 1232 below the tapered portion 1220 of the tubular sleeve 1216 in order to couple the tubular sleeve to the first tubular member.

[00128] In an exemplary embodiment, the internally threaded connection 1212 of the end portion 1214 of the first tubular member 1210 is a box connection, and the externally threaded connection 1228 of the end portion 1230 of the second tubular member 1232 is a pin connection. In an exemplary embodiment, the internal diameter of the tubular sleeve 1216 is at least approximately .020" greater than the outside diameters of the end portions, 1214 and 1230, of the first and second tubular members, 1210 and 1232. In this manner, during the threaded coupling of the first and second tubular members, 1210 and 1232, fluidic materials within the first and second tubular members may be vented from the tubular members.

[00129] In an exemplary embodiment, as illustrated in Figs. 10d and 10e, the first and second tubular members, 1210 and 1232, and the tubular sleeve 1216 may then be positioned within another structure 32 such as, for example, a wellbore, and radially expanded and plastically deformed, for example, by moving an expansion cone 34 through the interiors of the first and second tubular members. The movement of the expansion cone 34 through the interiors of the first and second tubular members, 1210 and 1232, may be from top to bottom or from bottom to top.

[00130] In an exemplary embodiment, during the radial expansion and plastic deformation of the first and second tubular members, 1210 and 1232, the tubular sleeve 1216 is also radially expanded and plastically deformed. In an exemplary embodiment, as a result, the tubular sleeve 1216 may be maintained in circumferential tension and the end portions, 1214 and 1230, of the first and second tubular members, 1210 and 1232, may be maintained in circumferential compression.

[00131] The use of the tubular sleeve 1216 during (a) the coupling of the first tubular member 1210 to the second tubular member 1232, (b) the placement of the first and second tubular members in the structure 32, and (c) the radial expansion and plastic deformation of the first and second tubular members provides a number of significant benefits. For example, the tubular sleeve 1216 protects the exterior surfaces of the end portions, 1214 and 1230, of the first and second tubular members, 1210 and 1232, during handling and insertion of the tubular members within the structure 32. In this manner, damage to the exterior surfaces of the end portions, 1214 and 1230, of the first and second tubular members, 1210 and 1232, are prevented that could result in stress concentrations that could result in a catastrophic failure during subsequent radial expansion operations. Furthermore, the tubular sleeve 1216 provides an alignment guide that facilitates the insertion and threaded coupling of the

second tubular member 1232 to the first tubular member 1210. In this manner, misalignment that could result in damage to the threaded connections, 1212 and 1228, of the first and second tubular members, 1210 and 1232, may be avoided. Furthermore, the tubular sleeve 1216 may prevent crack propagation during the radial expansion and plastic deformation of the first and second tubular members, 1210 and 1232. In this manner, failure modes such as, for example, longitudinal cracks in the end portions, 1214 and 1230, of the first and second tubular members may be limited in severity or eliminated all together. In addition, after completing the radial expansion and plastic deformation of the first and second tubular members, 1210 and 1232, the tubular sleeve 1216 may provide a fluid tight metal-to-metal seal between interior surface of the tubular sleeve and the exterior surfaces of the end portions, 1214 and 1230, of the first and second tubular members. In this manner, fluidic materials are prevented from passing through the threaded connections, 1212 and 1228, of the first and second tubular members, 1210 and 1232, into the annulus between the first and second tubular members and the structure 32. Furthermore, because, following the radial expansion and plastic deformation of the first and second tubular members, 1210 and 1232, the tubular sleeve 1216 may be maintained in circumferential tension and the end portions, 1214 and 1230, of the first and second tubular members, 1210 and 1232, may be maintained in circumferential compression, axial loads and/or torque loads may be transmitted through the tubular sleeve. In addition, the tubular sleeve 1216 may also increase the collapse strength of the end portions, 1214 and 1230, of the first and second tubular members 1210 and 1232.

[00132] Referring to Fig. 11a, a first tubular member 1310 includes an internally threaded connection 1312 at an end portion 1314. As illustrated in Fig. 11b, a first end of a tubular sleeve 1316 having tapered portions, 1318 and 1320, at opposite ends is then mounted upon and receives the end portion 1314 of the first tubular member 1310. In an exemplary embodiment, an annular resilient retaining member 1322 is then positioned on the first tubular member 1310 below the bottom end of the tubular sleeve 1316 in order to couple the tubular sleeve to the first tubular member.

[00133] As illustrated in Fig. 11c, an externally threaded connection 1324 of an end portion 1326 of a second tubular member 1328 is then positioned within the tubular sleeve 1316 and threadably coupled to the internally threaded connection 1312 of the end portion 1314 of the first tubular member 1310. In an exemplary embodiment, an annular resilient retaining member 1330 is then positioned on the second tubular member 1328 above the top end of the tubular sleeve 1316 in order to couple the tubular sleeve to the second tubular member.

[00134] In an exemplary embodiment, the internally threaded connection 1312 of the end portion 1314 of the first tubular member 1310 is a box connection, and the externally threaded connection 1324 of the end portion 1326 of the second tubular member 1328 is a pin connection. In an exemplary embodiment, the internal diameter of the tubular sleeve 1316 is at least approximately .020" greater than the outside diameters of the end portions, 1314 and 1326, of the first and second tubular members,

1310 and 1328. In this manner, during the threaded coupling of the first and second tubular members, 1310 and 1328, fluidic materials within the first and second tubular members may be vented from the tubular members.

[00135] In an exemplary embodiment, as illustrated in Figs. 11d and 11e, the first and second tubular members, 1310 and 1328, and the tubular sleeve 1316 may then be positioned within another structure 32 such as, for example, a wellbore, and radially expanded and plastically deformed, for example, by moving an expansion cone 34 through the interiors of the first and second tubular members. The movement of the expansion cone 34 through the interiors of the first and second tubular members, 1310 and 1328, may be from top to bottom or from bottom to top.

[00136] In an exemplary embodiment, during the radial expansion and plastic deformation of the first and second tubular members, 1310 and 1328, the tubular sleeve 1316 is also radially expanded and plastically deformed. In an exemplary embodiment, as a result, the tubular sleeve 1316 may be maintained in circumferential tension and the end portions, 1314 and 1326, of the first and second tubular members, 1310 and 1328, may be maintained in circumferential compression.

[00137] The use of the tubular sleeve 1316 during (a) the coupling of the first tubular member 1310 to the second tubular member 1328, (b) the placement of the first and second tubular members in the structure 32, and (c) the radial expansion and plastic deformation of the first and second tubular members provides a number of significant benefits. For example, the tubular sleeve 1316 protects the exterior surfaces of the end portions, 1314 and 1326, of the first and second tubular members, 1310 and 1328, during handling and insertion of the tubular members within the structure 32. In this manner, damage to the exterior surfaces of the end portions, 1314 and 1326, of the first and second tubular members, 1310 and 1328, are prevented that could result in stress concentrations that could result in a catastrophic failure during subsequent radial expansion operations. Furthermore, the tubular sleeve 1316 provides an alignment guide that facilitates the insertion and threaded coupling of the second tubular member 1328 to the first tubular member 1310. In this manner, misalignment that could result in damage to the threaded connections, 1312 and 1324, of the first and second tubular members, 1310 and 1328, may be avoided. Furthermore, the tubular sleeve 1316 may prevent crack propagation during the radial expansion and plastic deformation of the first and second tubular members, 1310 and 1328. In this manner, failure modes such as, for example, longitudinal cracks in the end portions, 1314 and 1326, of the first and second tubular members may be limited in severity or eliminated all together. In addition, after completing the radial expansion and plastic deformation of the first and second tubular members, 1310 and 1328, the tubular sleeve 1316 may provide a fluid tight metal-to-metal seal between interior surface of the tubular sleeve and the exterior surfaces of the end portions, 1314 and 1326, of the first and second tubular members. In this manner, fluidic materials are prevented from passing through the threaded connections, 1312 and 1324, of the first and second tubular members, 1310 and 1328, into the annulus between the first and second tubular members and

the structure 32. Furthermore, because, following the radial expansion and plastic deformation of the first and second tubular members, 1310 and 1328, the tubular sleeve 1316 may be maintained in circumferential tension and the end portions, 1314 and 1326, of the first and second tubular members, 1310 and 1328, may be maintained in circumferential compression, axial loads and/or torque loads may be transmitted through the tubular sleeve. In addition, the tubular sleeve 1316 may also increase the collapse strength of the end portions, 1314 and 1326, of the first and second tubular members, 1310 and 1328.

[00138] Referring to Fig. 12a, a first tubular member 1410 includes an internally threaded connection 1412 and an annular recess 1414 at an end portion 1416. As illustrated in Fig. 12b, a first end of a tubular sleeve 1418 that includes an external flange 1420 and tapered portions, 1422 and 1424, at opposite ends is then mounted within the end portion 1416 of the first tubular member 1410. In an exemplary embodiment, the external flange 1420 of the tubular sleeve 1418 is received within and is supported by the annular recess 1414 of the end portion 1416 of the first tubular member 1410. As illustrated in Fig. 12c, an externally threaded connection 1426 of an end portion 1428 of a second tubular member 1430 is then positioned around a second end of the tubular sleeve 1418 and threadably coupled to the internally threaded connection 1412 of the end portion 1414 of the first tubular member 1410. In an exemplary embodiment, the external flange 1420 of the tubular sleeve 1418 mates with and is received within the annular recess 1416 of the end portion 1414 of the first tubular member 1410, and the external flange of the tubular sleeve is retained in the annular recess by the end portion 1428 of the second tubular member 1430. Thus, the tubular sleeve 1416 is coupled to and is surrounded by the internal surfaces of the first and second tubular members, 1410 and 1430.

[00139] In an exemplary embodiment, the internally threaded connection 1412 of the end portion 1414 of the first tubular member 1410 is a box connection, and the externally threaded connection 1426 of the end portion 1428 of the second tubular member 1430 is a pin connection. In an exemplary embodiment, the external diameter of the tubular sleeve 1418 is at least approximately .020" less than the inside diameters of the first and second tubular members, 1410 and 1430. In this manner, during the threaded coupling of the first and second tubular members, 1410 and 1430, fluidic materials within the first and second tubular members may be vented from the tubular members.

[00140] In an exemplary embodiment, as illustrated in Figs. 12d and 12e, the first and second tubular members, 1410 and 1430, and the tubular sleeve 1418 may then be positioned within another structure 32 such as, for example, a wellbore, and radially expanded and plastically deformed, for example, by moving an expansion cone 34 through the interiors of the first and second tubular members. The tapered portions, 1422 and 1424, of the tubular sleeve 1418 facilitate the movement of the expansion cone 34 through the first and second tubular members, 1410 and 1430, and the movement of the expansion cone 34 through the interiors of the first and second tubular members, 1410 and 1430, may be from top to bottom or from bottom to top.

[00141] In an exemplary embodiment, during the radial expansion and plastic deformation of the first and second tubular members, 1410 and 1430, the tubular sleeve 1418 is also radially expanded and plastically deformed. In an exemplary embodiment, as a result, the tubular sleeve 1418 may be maintained in circumferential compression and the end portions, 1414 and 1428, of the first and second tubular members, 1410 and 1430, may be maintained in circumferential tension.

[00142] In several alternative embodiments, the first and second tubular members, 1410 and 1430, are radially expanded and plastically deformed using other conventional methods for radially expanding and plastically deforming tubular members such as, for example, internal pressurization and/or roller expansion devices.

[00143] The use of the tubular sleeve 1418 during (a) the coupling of the first tubular member 1410 to the second tubular member 1430, (b) the placement of the first and second tubular members in the structure 32, and (c) the radial expansion and plastic deformation of the first and second tubular members provides a number of significant benefits. For example, the tubular sleeve 1418 provides an alignment guide that facilitates the insertion and threaded coupling of the second tubular member 1430 to the first tubular member 1410. In this manner, misalignment that could result in damage to the threaded connections, 1412 and 1426, of the first and second tubular members, 1410 and 1430, may be avoided. In addition, during the relative rotation of the second tubular member with respect to the first tubular member, required during the threaded coupling of the first and second tubular members, the tubular sleeve 1418 provides an indication of to what degree the first and second tubular members are threadably coupled. For example, if the tubular sleeve 1418 can be easily rotated, that would indicate that the first and second tubular members, 1410 and 1430, are not fully threadably coupled and in intimate contact with the internal flange 1420 of the tubular sleeve. Furthermore, the tubular sleeve 1418 may prevent crack propagation during the radial expansion and plastic deformation of the first and second tubular members, 1410 and 1430. In this manner, failure modes such as, for example, longitudinal cracks in the end portions, 1414 and 1428, of the first and second tubular members may be limited in severity or eliminated all together. In addition, after completing the radial expansion and plastic deformation of the first and second tubular members, 1410 and 1430, the tubular sleeve 1418 may provide a fluid tight metal-to-metal seal between the exterior surface of the tubular sleeve and the interior surfaces of the end portions, 1414 and 1428, of the first and second tubular members. In this manner, fluidic materials are prevented from passing through the threaded connections, 1412 and 1426, of the first and second tubular members, 1410 and 1430, into the annulus between the first and second tubular members and the structure 32. Furthermore, because, following the radial expansion and plastic deformation of the first and second tubular members, 1410 and 1430, the tubular sleeve 1418 may be maintained in circumferential compression and the end portions, 1414 and 1428, of the first and second tubular members, 1410 and 1430, may be maintained in circumferential tension, axial loads and/or torque loads may be transmitted through the tubular sleeve. In addition, the tubular sleeve 1418

may also increase the collapse strength of the end portions, 1414 and 1428, of the first and second tubular members, 1410 and 1430.

[00144] Referring to Fig. 13a, an end of a first tubular member 1510 is positioned within and coupled to an end of a tubular sleeve 1512 having an internal flange 1514. In an exemplary embodiment, the end of the first tubular member 1510 abuts one side of the internal flange 1514. As illustrated in Fig. 13b, an end of second tubular member 1516 is then positioned within and coupled to another end of the tubular sleeve 1512. In an exemplary embodiment, the end of the second tubular member 1516 abuts another side of the internal flange 1514. In an exemplary embodiment, the tubular sleeve 1512 is coupled to the ends of the first and second tubular members, 1510 and 1516, by expanding the tubular sleeve 1512 using heat and then inserting the ends of the first and second tubular members into the expanded tubular sleeve 1512. After cooling the tubular sleeve 1512, the tubular sleeve is coupled to the ends of the first and second tubular members, 1510 and 1516.

[00145] In an exemplary embodiment, as illustrated in Figs. 13c and 13d, the first and second tubular members, 1510 and 1516, and the tubular sleeve 1512 may then be positioned within another structure 32 such as, for example, a wellbore, and radially expanded and plastically deformed, for example, by moving an expansion cone 34 through the interiors of the first and second tubular members. The movement of the expansion cone 34 through the interiors of the first and second tubular members, 1510 and 1516, may be from top to bottom or from bottom to top.

[00146] In an exemplary embodiment, during the radial expansion and plastic deformation of the first and second tubular members, 1510 and 1516, the tubular sleeve 1512 is also radially expanded and plastically deformed. In an exemplary embodiment, as a result, the tubular sleeve 1512 may be maintained in circumferential tension and the ends of the first and second tubular members, 1510 and 1516, may be maintained in circumferential compression.

[00147] The use of the tubular sleeve 1512 during (a) the placement of the first and second tubular members, 1510 and 1516, in the structure 32 and (b) the radial expansion and plastic deformation of the first and second tubular members provides a number of significant benefits. For example, the tubular sleeve 1512 may prevent crack propagation during the radial expansion and plastic deformation of the first and second tubular members, 1510 and 1516. In this manner, failure modes such as, for example, longitudinal cracks in the ends of the first and second tubular members, 1510 and 1516, may be limited in severity or eliminated all together. In addition, after completing the radial expansion and plastic deformation of the first and second tubular members, 1510 and 1516, the tubular sleeve 1512 may provide a fluid tight metal-to-metal seal between the exterior surface of the tubular sleeve and the interior surfaces of the end of the first and second tubular members. Furthermore, because, following the radial expansion and plastic deformation of the first and second tubular members, 1510 and 1516, the tubular sleeve 1512 may be maintained in circumferential compression and the ends of the first and second tubular members, 1510 and 1516, may be maintained in circumferential tension, axial loads

and/or torque loads may be transmitted through the tubular sleeve. In addition, the tubular sleeve 1512 may also increase the collapse strength of the end portions of the first and second tubular members, 1510 and 1516.

[00148] Referring to Fig. 14a, a first tubular member 1610 includes a resilient retaining ring 1612 mounted within an annular recess 1614. As illustrated in Fig. 14b, the end of the first tubular member 1610 is then inserted into and coupled to an end of a tubular sleeve 1616 including an internal flange 1618 and annular recesses, 1620 and 1622, positioned on opposite sides of the internal flange, tapered portions, 1624 and 1626, on one end of the tubular sleeve, and tapered portions, 1628 and 1630, on the other end of the tubular sleeve. In an exemplary embodiment, the resilient retaining ring 1612 is thereby positioned at least partially in the annular recesses, 1614 and 1620, thereby coupling the first tubular member 1610 to the tubular sleeve 1616, and the end of the first tubular member 1610 abuts one side of the internal flange 1618. During the coupling of the first tubular member 1610 to the tubular sleeve 1616, the tapered portion 1630 facilitates the radial compression of the resilient retaining ring 1612 during the insertion of the first tubular member into the tubular sleeve.

[00149] As illustrated in Fig. 14c, an end of a second tubular member 1632 that includes a resilient retaining ring 1634 mounted within an annular recess 1636 is then inserted into and coupled to another end of the tubular sleeve 1616. In an exemplary embodiment, the resilient retaining ring 1634 is thereby positioned at least partially in the annular recesses, 1636 and 1622, thereby coupling the second tubular member 1632 to the tubular sleeve 1616, and the end of the second tubular member 1632 abuts another side of the internal flange 1618. During the coupling of the second tubular member 1632 to the tubular sleeve 1616, the tapered portion 1626 facilitates the radial compression of the resilient retaining ring 1634 during the insertion of the second tubular member into the tubular sleeve.

[00150] In an exemplary embodiment, as illustrated in Figs. 14d and 14e, the first and second tubular members, 1610 and 1632, and the tubular sleeve 1616 may then be positioned within another structure 32 such as, for example, a wellbore, and radially expanded and plastically deformed, for example, by moving an expansion cone 34 through the interiors of the first and second tubular members. The movement of the expansion cone 34 through the interiors of the first and second tubular members, 1610 and 1632, may be from top to bottom or from bottom to top.

[00151] In an exemplary embodiment, during the radial expansion and plastic deformation of the first and second tubular members, 1610 and 1632, the tubular sleeve 1616 is also radially expanded and plastically deformed. In an exemplary embodiment, as a result, the tubular sleeve 1616 may be maintained in circumferential tension and the ends of the first and second tubular members, 1610 and 1632, may be maintained in circumferential compression.

[00152] The use of the tubular sleeve 1616 during (a) the placement of the first and second tubular members, 1610 and 1632, in the structure 32, and (b) the radial expansion and plastic deformation of the first and second tubular members provides a number of significant benefits. For example, the

tubular sleeve 1616 protects the exterior surfaces of the ends of the first and second tubular members, 1610 and 1632, during handling and insertion of the tubular members within the structure 32. In this manner, damage to the exterior surfaces of the ends of the first and second tubular member, 1610 and 1632, are prevented that could result in stress concentrations that could result in a catastrophic failure during subsequent radial expansion operations. Furthermore, the tubular sleeve 1616 may prevent crack propagation during the radial expansion and plastic deformation of the first and second tubular members, 1610 and 1632. In this manner, failure modes such as, for example, longitudinal cracks in the ends of the first and second tubular members, 1610 and 1632, may be limited in severity or eliminated all together. In addition, after completing the radial expansion and plastic deformation of the first and second tubular members, 1610 and 1632, the tubular sleeve 1616 may provide a fluid tight metal-to-metal seal between interior surface of the tubular sleeve and the exterior surfaces of the ends of the first and second tubular members. Furthermore, because, following the radial expansion and plastic deformation of the first and second tubular members, 1610 and 1632, the tubular sleeve 1616 may be maintained in circumferential tension and the ends of the first and second tubular members, 1610 and 1632, may be maintained in circumferential compression, axial loads and/or torque loads may be transmitted through the tubular sleeve. In addition, the tubular sleeve 1616 may also increase the collapse strength of the end portions of the first and second tubular members, 1610 and 1632.

[00153] Referring to Fig. 15a, a first tubular member 1700 defines a passage 1702 and a counterbore 1704 at an end portion 1706. The counterbore 1704 includes a tapered shoulder 1708, an annular recess 1710, non-tapered internal threads, 1712, and tapered internal threads 1714. A second tubular member 1716 that defines a passage 1718 includes a recessed portion 1720 at an end portion 1722 that includes a tapered end portion 1724 that is adapted to mate with the tapered shoulder 1708 of the counterbore 1704 of the first tubular member 1700, non-tapered external threads 1726 adapted to mate with the non-tapered internal threads 1712 of the counterbore of the first tubular member, and tapered external threads 1728 adapted to mate with the tapered internal threads 1714 of the counterbore of the first tubular member. A sealing ring 1730 is received within the annular recess 1710 of the counterbore 1704 of the of the first tubular member 1700 for fluidicly sealing the interface between the counterbore of the first tubular member and the recessed portion 1720 of the second tubular member 1716. In an exemplary embodiment, the threads, 1712, 1714, 1726, and 1728, are left-handed threads in order to prevent de-coupling of the first and second tubular members, 1700 and 1716, during placement of the tubular members within the structure 32. In an exemplary embodiment, the sealing ring 1730 is an elastomeric sealing ring.

[00154] A tubular sleeve 1732 that defines a passage 1734 for receiving the end portions, 1706 and 1722, of the first and second tubular members, 1700 and 1716, respectively, includes an internal flange 1736 that mates with and is received within an annular recess 1738 that is defined between an end face 1740 of the end portion of the first tubular member and an end face 1742 of the recessed portion 1720

of the end portion of the second tubular member. In this manner, the tubular sleeve 1732 is coupled to the first and second tubular members, 1700 and 1716. The tubular sleeve 1732 further includes first and second internal annular recesses, 1744 and 1746, internal tapered flanges, 1748 and 1750, and external tapered flanges, 1752 and 1754.

[00155] Sealing members, 1756 and 1758, are received within and mate with the internal annular recesses, 1744 and 1746, respectively, of the tubular sleeve 1732 that fluidicly seal the interface between the tubular sleeve and the first and second tubular members, 1700 and 1716, respectively. A sealing member 1760 is coupled to the exterior surface of the tubular sleeve 1732 for fluidicly sealing the interface between the tubular sleeve and the interior surface of the preexisting structure 32 following the radial expansion of the first and second tubular members, 1700 and 1716, and the tubular sleeve using the expansion cone 34. In an exemplary embodiment, the sealing members, 1756 and 1758, may be, for example, elastomeric or non-elastomeric sealing members fabricated from nitrile, viton, or TeflonJ materials. In an exemplary embodiment, the sealing member 1760 is fabricated from an elastomeric material.

[00156] In an exemplary embodiment, during the radial expansion and plastic deformation of the first and second tubular members, 1700 and 1716, the tubular sleeve 1732 is also radially expanded and plastically deformed. In an exemplary embodiment, as a result of the radial expansion, the tubular sleeve 1732 may be maintained in circumferential tension and the end portions, 1706 and 1722, of the first and second tubular members, 1700 and 1716, may be maintained in circumferential compression. Furthermore, in an exemplary embodiment, during and following the radial expansion and plastic deformation of the first and second tubular members, 1700 and 1716, respectively: (a) the sealing members, 1756 and 1758, of the tubular sleeve 1732 engage and fluidicly seal the interface between the tubular sleeve and the end portions, 1706 and 1722, of the first and second tubular members, (b) the internal tapered flanges, 1748 and 1750, of the tubular sleeve engage, and couple the tubular sleeve to, the end portions of the first and second tubular members, (c) the external tapered flanges, 1752 and 1754, of the tubular sleeve engage, and couple the tubular sleeve to, the structure 32, and (d) the sealing member 1760 engages and fluidicly seals the interface between the tubular sleeve and the structure.

[00157] In several exemplary embodiments, the first and second tubular members, 1700 and 1716, are radially expanded and plastically deformed using the expansion cone 34 in a conventional manner and/or using one or more of the methods and apparatus disclosed in one or more of the following: (1) U.S. patent application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, (3) U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, (4) U.S. patent application serial no. 09/440,338, attorney docket no. 25791.9.02, filed on 11/15/1999, (5) U.S. patent application serial no. 09/523,460, attorney docket no. 25791.11.02, filed on 3/10/2000, (6)

U.S. patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, (7) U.S. patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on 2/24/2000, (8) U.S. patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, (9) U.S. patent application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, (10) PCT patent application serial no. PCT/US00/18635, attorney docket no. 25791.25.02, filed on 7/9/2000, (11) U.S. provisional patent application serial no. 60/162,671, attorney docket no. 25791.27, filed on 11/1/1999, (12) U.S. provisional patent application serial no. 60/154,047, attorney docket no. 25791.29, filed on 9/16/1999, (13) U.S. provisional patent application serial no. 60/159,082, attorney docket no. 25791.34, filed on 10/12/1999, (14) U.S. provisional patent application serial no. 60/159,039, attorney docket no. 25791.36, filed on 10/12/1999, (15) U.S. provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (16) U.S. provisional patent application serial no. 60/212,359, attorney docket no. 25791.38, filed on 6/19/2000, (17) U.S. provisional patent application serial no. 60/165,228, attorney docket no. 25791.39, filed on 11/12/1999, (18) U.S. provisional patent application serial no. 60/221,443, attorney docket no. 25791.45, filed on 7/28/2000, (19) U.S. provisional patent application serial no. 60/221,645, attorney docket no. 25791.46, filed on 7/28/2000, (20) U.S. provisional patent application serial no. 60/233,638, attorney docket no. 25791.47, filed on 9/18/2000, (21) U.S. provisional patent application serial no. 60/237,334, attorney docket no. 25791.48, filed on 10/2/2000, (22) U.S. provisional patent application serial no. 60/270,007, attorney docket no. 25791.50, filed on 2/20/2001, (23) U.S. provisional patent application serial no. 60/262,434, attorney docket no. 25791.51, filed on 1/17/2001, (24) U.S, provisional patent application serial no. 60/259,486, attorney docket no. 25791.52, filed on 1/3/2001, (25) U.S. provisional patent application serial no. 60/303,740, attorney docket no. 25791.61, filed on 7/6/2001, (26) U.S. provisional patent application serial no. 60/313,453, attorney docket no. 25791.59, filed on 8/20/2001, (27) U.S. provisional patent application serial no. 60/317,985, attorney docket no. 25791.67, filed on 9/6/2001, (28) U.S. provisional patent application serial no. 60/3318,386, attorney docket no. 25791.67.02, filed on 9/10/2001, (29) U.S. utility patent application serial no. 09/969,922, attorney docket no. 25791.69, filed on 10/3/2001, (30) U.S. utility patent application serial no. 10/016,467, attorney docket no. 25791.70, filed on 12/10/2001; (31) U.S. provisional patent application serial no. 60/343,674, attorney docket no. 25791.68, filed on 12/27/2001; (32) U.S. provisional patent application serial no. 60/346,309, attorney docket no 25791.92, filed on 1/7/2002; (33) U.S. provisional patent application serial no. 60/372,048, attorney docket no. 25791.93, filed on 4/12/2002; (34) U.S. provisional patent application serial no. 60/380,147, attorney docket no. 25791.104, filed on 5/6/2002; (35) U.S. provisional patent application serial no. 60/387,486, attorney docket no. 25791.107, filed on 6/10/2002; (36) U.S. provisional patent application serial no. 60/387,961, attorney docket no. 25791.108, filed on 6/12/2002; and (37) U.S. provisional patent application serial no. 60/391,703, attorney docket no. 25791.90, filed on 6/26/2002,

the disclosures of which are incorporated herein by reference.

[00158] In several alternative embodiments, the first and second tubular members, 1700 and 1716, are radially expanded and plastically deformed using other conventional methods for radially expanding and plastically deforming tubular members such as, for example, internal pressurization and/or roller expansion devices such as, for example, that disclosed in U.S. patent application publication no. US 2001/0045284 A1, the disclosure of which is incorporated herein by reference.

[00159] The use of the tubular sleeve 1732 during (a) the threaded coupling of the first tubular member 1700 to the second tubular member 1716, (b) the placement of the first and second tubular members in the structure 32, and (c) the radial expansion and plastic deformation of the first and second tubular members provides a number of significant benefits. For example, the tubular sleeve 1732 protects the exterior surfaces of the end portions, 1706 and 1722, of the first and second tubular members, 1700 and 1716, during handling and insertion of the tubular members within the structure 32. In this manner, damage to the exterior surfaces of the end portions, 1706 and 1722, of the first and second tubular member, 1700 and 1716, are prevented that could result in stress concentrations that could result in a catastrophic failure during subsequent radial expansion operations. Furthermore, the tubular sleeve 1732 provides an alignment guide that facilitates the insertion and threaded coupling of the second tubular member 1716 to the first tubular member 1700. In this manner, misalignment that could result in damage to the threaded connections, 1712, 1714, 1726, and 1728, of the first and second tubular members, 1700 and 1716, may be avoided. In addition, during the relative rotation of the second tubular member with respect to the first tubular member, required during the threaded coupling of the first and second tubular members, the tubular sleeve 1732 provides an indication of to what degree the first and second tubular members are threadably coupled. For example, if the tubular sleeve 1732 can be easily rotated, that would indicate that the first and second tubular members, 1700 and 1716, are not fully threadably coupled and in intimate contact with the internal flange 1736 of the tubular sleeve. Furthermore, the tubular sleeve 1732 may prevent crack propagation during the radial expansion and plastic deformation of the first and second tubular members, 1700 and 1716. In this manner, failure modes such as, for example, longitudinal cracks in the end portions, 1706 and 1722, of the first and second tubular members may be limited in severity or eliminated all together. In addition, after completing the radial expansion and plastic deformation of the first and second tubular members, 1700 and 1716, the tubular sleeve 16 may provide a fluid tight metal-to-metal seal between interior surface of the tubular sleeve and the exterior surfaces of the end portions, 1706 and 1722, of the first and second tubular members. In this manner, fluidic materials are prevented from passing through the threaded connections, 1712, 1714, 1726, and 1728, of the first and second tubular members, 1700 and 1716, into the annulus between the first and second tubular members and the structure 32. Furthermore, because, following the radial expansion and plastic deformation of the first and second tubular members, 1700 and 1716, the tubular sleeve 1732 may be maintained in circumferential

tension and the end portions, 1706 and 1722, of the first and second tubular members, 1700 and 1716, may be maintained in circumferential compression, axial loads and/or torque loads may be transmitted through the tubular sleeve. In addition, the tubular sleeve 1732 may also increase the collapse strength of the end portions, 1706 and 1722, of the first and second tubular members, 1700 and 1716.

[00160] In an exemplary experimental implementation, following the radial expansion and plastic deformation of the first and second tubular members, 1700 and 1716, and the tubular sleeve 1732, the threads, 1712, 1714, 1726, and 1728, of the end portions, 1706 and 1722, of the first and second tubular members were unexpectedly deformed such that a fluidic seal was unexpectedly formed between and among the threads of the first and second tubular members. In this manner, a fluid tight seal was unexpectedly provided between the first and second tubular member, 1700 and 1716, due to the presence of the tubular sleeve 1732 during the radial expansion and plastic deformation of the end portions, 1706 and 1722, of the first and second tubular members.

[00161] In an exemplary embodiment, the rate and degree of radial expansion and plastic deformation of the first and second tubular members, 1700 and 1716, and the tubular sleeve 1732 are adjusted to generate sufficient localized heating to result in amorphous bonding or welding of the threads, 1712, 1714, 1726, and 1728. As a result, the first and second tubular members, 1700 and 1716, may be amorphously bonded resulting a joint between the first and second tubulars that is nearly metallurgically homogeneous.

[00162] In an alternative embodiment, as illustrated in Fig. 15c, a metallic foil 1762 of a suitable alloy is placed between and among the threads, 1712, 1714, 1726, and 1728, and during the radial expansion and plastic deformation of the first and second tubular members, 1700 and 1716, and the tubular sleeve 1732, localized heating of the region proximate the threads, 1712, 1714, 1726, and 1728, results in amorphous bonding or a brazing joint of the threads. As a result, the first and second tubular members, 1700 and 1716, may be amorphously bonded resulting a joint between the first and second tubulars that is nearly metallurgically homogeneous.

[00163] In an exemplary embodiment, as illustrated in Fig. 16, a plurality of overlapping wellbore casing strings 1800a-1800h, are positioned within a borehole 1802 that traverses a subterranean source 1804 of geothermal energy. In this manner, geothermal energy may then be extracted from the subterranean source 1804 geothermal energy using conventional methods of extraction. In an exemplary embodiment, one or more of the wellbore casing strings 1800 include one or more of the first and second tubular members, 10, 28, 910, 938, 1010, 1036, 1110, 1128, 1210, 1232, 1310, 1328, 1410, 1430, 1510, 1516, 1610, 1632, 1700 and/or 1716, that are coupled end-to-end and include one or more of the tubular sleeves, 16, 110, 210, 310, 410, 510, 610, 710, 810, 918, 1018, 1116, 1216, 1316, 1418, 1512, 1616 and/or 1732.

[00164] In an exemplary embodiment, the wellbore casing strings, 1800a-1800h, are radially expanded and plastically deformed in overlapping fashion within the borehole 1802.

[00165] For example, the wellbore casing string 1800a is positioned within the borehole 1802 and then radially expanded and plastically deformed. The wellbore casing string 1800b is then positioned within the borehole 1802 in overlapping relation to the wellbore casing string 1800a and then radially expanded and plastically deformed. In this manner, a mono-diameter wellbore casing may be formed that includes the overlapping wellbore casing strings 1800a and 1800b. This process may then be repeated for wellbore casing strings 1800c-1800h. As a result, a mono-diameter wellbore casing may be produced that extends from a surface location to the source 1804 of geothermal energy in which the inside diameter of a passage 1806 defined by the interiors of the wellbore casing strings 1800a-1800h is constant. In this manner, the geothermal energy from the source 1804 may be efficiently and economically extracted. Furthermore, because variations in the inside diameter of the wellbore casing strings 1800 is eliminated by the resulting mono-diameter design, the depth of the borehole 1802 may be virtually limitless. As a result, using the teachings of the present exemplary embodiments, sources of geothermal energy can now be extracted from depths of over 50,000 feet.

[00166] In several exemplary embodiments, the wellbore casing strings 1800a-1800h are radially expanded and plastically deformed using the expansion cone 34 using one or more of the methods and apparatus disclosed in one or more of the following: (1) U.S. patent application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, (3) U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, (4) U.S. patent application serial no. 09/440,338, attorney docket no. 25791.9.02, filed on 11/15/1999, (5) U.S. patent application serial no. 09/523,460, attorney docket no. 25791.11.02, filed on 3/10/2000, (6) U.S. patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, (7) U.S. patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on 2/24/2000, (8) U.S. patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, (9) U.S. patent application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, (10) PCT patent application serial no. PCT/US00/18635, attorney docket no. 25791.25.02, filed on 7/9/2000, (11) U.S. provisional patent application serial no. 60/162,671, attorney docket no. 25791.27, filed on 11/1/1999, (12) U.S. provisional patent application serial no. 60/154,047, attorney docket no. 25791.29, filed on 9/16/1999, (13) U.S. provisional patent application serial no. 60/159,082, attorney docket no. 25791.34, filed on 10/12/1999, (14) U.S. provisional patent application serial no. 60/159,039, attorney docket no. 25791.36, filed on 10/12/1999, (15) U.S. provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (16) U.S. provisional patent application serial no. 60/212,359, attorney docket no. 25791.38, filed on 6/19/2000, (17) U.S. provisional patent application serial no. 60/165,228, attorney docket no. 25791.39, filed on 11/12/1999, (18) U.S. provisional patent application serial no. 60/221,443, attorney docket no. 25791.45, filed on 7/28/2000, (19) U.S. provisional patent application serial no. 60/221,645, attorney docket no. 25791.46, filed on 7/28/2000,

(20) U.S. provisional patent application serial no. 60/233,638, attorney docket no. 25791.47, filed on 9/18/2000, (21) U.S. provisional patent application serial no. 60/237,334, attorney docket no. 25791.48, filed on 10/2/2000, (22) U.S. provisional patent application serial no. 60/270,007, attorney docket no. 25791.50, filed on 2/20/2001, (23) U.S. provisional patent application serial no. 60/262,434, attorney docket no. 25791.51, filed on 1/17/2001, (24) U.S, provisional patent application serial no. 60/259,486, attorney docket no. 25791.52, filed on 1/3/2001, (25) U.S. provisional patent application serial no. 60/303,740, attorney docket no. 25791.61, filed on 7/6/2001, (26) U.S. provisional patent application serial no. 60/313,453, attorney docket no. 25791.59, filed on 8/20/2001, (27) U.S. provisional patent application serial no. 60/317,985, attorney docket no. 25791.67, filed on 9/6/2001, (28) U.S. provisional patent application serial no. 60/3318,386, attorney docket no. 25791.67.02, filed on 9/10/2001, (29) U.S. utility patent application serial no. 09/969,922, attorney docket no. 25791.69, filed on 10/3/2001, (30) U.S. utility patent application serial no. 10/016,467, attorney docket no. 25791.70, filed on 12/10/2001; (31) U.S. provisional patent application serial no. 60/343,674, attorney docket no. 25791.68, filed on 12/27/2001; (32) U.S. provisional patent application serial no. 60/346,309, attorney docket no 25791.92, filed on 1/7/2002; (33) U.S. provisional patent application serial no. 60/372,048, attorney docket no. 25791.93, filed on 4/12/2002; (34) U.S. provisional patent application serial no. 60/380,147, attorney docket no. 25791.104, filed on 5/6/2002; (35) U.S. provisional patent application serial no. 60/387,486, attorney docket no. 25791.107, filed on 6/10/2002; (36) U.S. provisional patent application serial no. 60/387,961, attorney docket no. 25791.108, filed on 6/12/2002; and (37) U.S. provisional patent application serial no. 60/391,703, attorney docket no. 25791.90, filed on 6/26/2002, the disclosures of which are incorporated herein by reference.

[00167] Referring to Fig. 17a, a first tubular member 1900 defines a passage 1902 and a counterbore 1904 at an end portion 1906. The counterbore 1904 includes non-tapered internal threads 1908, and tapered internal threads 1910. A second tubular member 1912 that defines a passage 1914 includes a recessed portion 1916 at an end portion 1918 that includes non-tapered external threads 1920 adapted to mate with the non-tapered internal threads 1908 of the counterbore of the first tubular member, and tapered external threads 1922 adapted to mate with the tapered internal threads 1910 of the counterbore of the first tubular member. In an exemplary embodiment, the threads, 1908, 1910, 1920, and 1922, are left-handed threads in order to prevent de-coupling of the first and second tubular members, 1900 and 1912, during handling of tubular members.

[00168] A tubular sleeve 1924 that defines a passage 1926 for receiving the end portions, 1906 and 1918, of the first and second tubular members, 1900 and 1912, respectively, includes an internal flange 1928 that mates with and is received within an annular recess 1930 that is defined between an end face 1932 of the end portion of the first tubular member and an end face 1934 of the recessed portion 1916 of the end portion of the second tubular member. In this manner, the tubular sleeve 1924 is coupled to

the first and second tubular members, 1900 and 1912.

[00169] An adjustable expansion cone 1936 supported by a support member 1938 may then lowered into the first and second tubular members, 1900 and 1912, to a position proximate the vicinity of the threads, 1908, 1910, 1920, and 1922. As illustrated in Fig. 17b, The expansion cone 1936 may then be controllably increased in size until the outside circumference of the expansion cone engages and radially expands and plastically deforms the end portions of the first and second tubular members, 1900 and 1912, proximate the expansion cone. The expansion cone 1936 may then be displaced in the longitudinal direction 1940 thereby radially expanding and plastically deforming the remaining portions of the first and second tubular members, 1900 and 1912, in the vicinity of the threads, 1908, 1910, 1920, and 1922. In several exemplary embodiments, the amount of radial expansion ranged from less than about one percent to less than about five percent.

[00170] After completing the radial expansion and plastic deformation of the portions 1942 of the first and second tubular members, 1900 and 1912, in the vicinity of the threads, 1908, 1910, 1920, and 1922, the expansion cone 1936 may then be controllably reduced in size until the outside circumference of the expansion cone disengages from the portion of the second tubular above the portion of the second tubular member in the vicinity of the threads. In this manner, only the portions 1942 of the first and second tubular members, 1900 and 1912, in the vicinity of the threads, 1908, 1910, 1920, and 1922, are radially expanded and plastically deformed.

[00171] In several exemplary embodiments, the portions 1942 of the first and second tubular members, 1900 and 1912, in the vicinity of the threads, 1908, 1910, 1920, are radially expanded and plastically deformed using one or more of the methods and apparatus disclosed in one or more of the following: (1) U.S. patent application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, (3) U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, (4) U.S. patent application serial no. 09/440,338, attorney docket no. 25791.9.02, filed on 11/15/1999, (5) U.S. patent application serial no. 09/523,460, attorney docket no. 25791.11.02, filed on 3/10/2000, (6) U.S. patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, (7) U.S. patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on 2/24/2000, (8) U.S. patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, (9) U.S. patent application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, (10) PCT patent application serial no. PCT/US00/18635, attorney docket no. 25791.25.02, filed on 7/9/2000, (11) U.S. provisional patent application serial no. 60/162,671, attorney docket no. 25791.27, filed on 11/1/1999, (12) U.S. provisional patent application serial no. 60/154,047, attorney docket no. 25791.29, filed on 9/16/1999, (13) U.S. provisional patent application serial no. 60/159,082, attorney docket no. 25791.34, filed on 10/12/1999, (14) U.S. provisional patent application serial no. 60/159,039, attorney docket no. 25791.36, filed on 10/12/1999, (15) U.S.

provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (16) U.S. provisional patent application serial no. 60/212,359, attorney docket no. 25791.38, filed on 6/19/2000, (17) U.S. provisional patent application serial no. 60/165,228, attorney docket no. 25791.39, filed on 11/12/1999, (18) U.S. provisional patent application serial no. 60/221,443, attorney docket no. 25791.45, filed on 7/28/2000, (19) U.S. provisional patent application serial no. 60/221,645, attorney docket no. 25791.46, filed on 7/28/2000, (20) U.S. provisional patent application serial no. 60/233,638, attorney docket no. 25791.47, filed on 9/18/2000, (21) U.S. provisional patent application serial no. 60/237,334, attorney docket no. 25791.48, filed on 10/2/2000, (22) U.S. provisional patent application serial no. 60/270,007, attorney docket no. 25791.50, filed on 2/20/2001, (23) U.S. provisional patent application serial no. 60/262,434, attorney docket no. 25791.51, filed on 1/17/2001, (24) U.S, provisional patent application serial no. 60/259,486, attorney docket no. 25791.52, filed on 1/3/2001, (25) U.S. provisional patent application serial no. 60/303,740, attorney docket no. 25791.61, filed on 7/6/2001, (26) U.S. provisional patent application serial no. 60/313,453, attorney docket no. 25791.59, filed on 8/20/2001, (27) U.S. provisional patent application serial no. 60/317,985, attorney docket no. 25791.67, filed on 9/6/2001, (28) U.S. provisional patent application serial no. 60/3318,386, attorney docket no. 25791.67.02, filed on 9/10/2001, (29) U.S. utility patent application serial no. 09/969,922, attorney docket no. 25791.69, filed on 10/3/2001, (30) U.S. utility patent application serial no. 10/016,467, attorney docket no. 25791.70, filed on 12/10/2001; (31) U.S. provisional patent application serial no. 60/343,674, attorney docket no. 25791.68, filed on 12/27/2001; (32) U.S. provisional patent application serial no. 60/346,309, attorney docket no 25791.92, filed on 1/7/2002; (33) U.S. provisional patent application serial no. 60/372,048, attorney docket no. 25791.93, filed on 4/12/2002; (34) U.S. provisional patent application serial no. 60/380,147, attorney docket no. 25791.104, filed on 5/6/2002; (35) U.S. provisional patent application serial no. 60/387,486, attorney docket no. 25791.107, filed on 6/10/2002; (36) U.S. provisional patent application serial no. 60/387,961, attorney docket no. 25791.108, filed on 6/12/2002; and (37) U.S. provisional patent application serial no. 60/391,703, attorney docket no. 25791.90, filed on 6/26/2002, the disclosures of which are incorporated herein by reference.

[00172] As illustrated in Fig. 17c, in an exemplary experimental implementation, prior to the radial expansion and plastic deformation of the portions 1942 of the first and second tubular members, 1900 and 1912, in the vicinity of the threads, 1908, 1910, 1920, and 1922, a variable gap 1944 is typically present between the threads, 1908 and 1920, and 1910 and 1922, that may permit fluidic materials to pass there through. The gap 1944 may be present, for example, in the radial, longitudinal and/or circumferential directions. The leakage of fluidic materials through the gap 1944 can cause serious problems, for example, in the extraction of subterranean fluids during oil or gas exploration and production operations, during the transport of hydrocarbons using underground pipelines, during the transport of pressurized fluids in a chemical processing plant, or within the heat exchanger tubes of a

power plant.

[00173] In an exemplary experimental implementation, as illustrated in Fig. 17d, following the radial expansion and plastic deformation of the portion 1942 of the first and second tubular members, 1900 and 1912, in the vicinity of the threads, 1908, 1910, 1920, and 1922, the gap 1944 between the threads was unexpectedly eliminated thereby creating a fluid tight seal. As a result a fluid tight seal may be provided within the threads, 1908, 1910, 1920, and 1922, of the first and second tubular members, 1900 and 1912, without an elastomeric, or other conventional, sealing element present.

[00174] Furthermore, in an exemplary experimental implementation, following the radial expansion and plastic deformation of the portions 1942 of the first and second tubular members, 1900 and 1912, in the vicinity of the threads, 1908, 1910, 1920, and 1922, a fluid tight seal was also created between the interior circumference of the tubular sleeve 1924 and the exterior circumferences of the first and second tubular members, 1900 and 1912.

[00175] Thus, the teachings of the present illustrative embodiments of Figs. 17a-17d may also be used to provide a fluid tight seal between the first and second tubular members, 10, 28, 910, 938, 1010, 1036, 1110, 1128, 1210, 1232, 1310, 1328, 1410, 1430, 1510, 1516, 1610, 1632, 1700 and/or 1716, that are coupled end-to-end and include one or more of the tubular sleeves, 16, 110, 210, 310, 410, 510, 610, 710, 810, 918, 1018, 1116, 1216, 1316, 1418, 1512, 1616 and/or 1732. A fluid tight seal may thereby be formed within the threaded connection between the adjacent tubular members and/or between the tubular sleeve and the adjacent tubular members.

[00176] More generally, the teachings of the present illustrative embodiments may be used to solve the problem of providing a fluid tight seal between all types of tubular members such as, for example, wellbore casings, pipes, underground pipelines, piping used in the transport of pressurized fluids in a chemical processing plant, or within the heat exchanger tubes of a power plant.

[00177] Furthermore, the teachings of the present illustrative embodiments may be used to solve the problem of providing a fluid tight seal between all types of tubular members such as, for example, wellbore casings, chemical processing pipes and underground pipelines, without having to radially expand and plastically deform the entire length of the tubular members. Instead, only those portions of the tubular members proximate the tubular sleeve provided adjacent to the joint between the tubular members needs to be radially expanded and plastically deformed. Furthermore, in an exemplary embodiment, the amount of radial expansion and plastic deformation ranged from less than about one percent to less than about five percent. As a result, the amount of time and resources typically needed to perform the radial expansion and plastic deformation is economical.

[00178] More generally, the teachings of the exemplary embodiments may be used to provide an inexpensive and reliable fluid tight seal between tubular members. In this manner, expensive and unreliable methods of providing a fluid tight seal between tubular members such as, for example, those methods utilized in the chemical processing industries and in power plant heat exchangers may be

replaced with the teachings of the present illustrative embodiments.

[00179] Furthermore, the teachings of the exemplary embodiments provide a method of radially expanding and plastically deforming the ends of adjacent coupled tubular members in which the freedom of movement of the adjacent ends of the coupled tubular members is constrained by the presence of the tubular sleeve. As a result, during the subsequent radial expansion process, the adjacent ends of the coupled tubular members are compressed into the plastic region of the stress-strain curve. Consequently, the material of the adjacent ends of the coupled tubular members such as, for example, the internal and external threads, flow into and fill any gaps or voids that may have existed within the junction of the coupled tubular members thereby providing a fluid tight seal. The creation of the fluid tight seal within the junction of the adjacent tubular members was an unexpected result that was discovered during experimental analysis and testing of the present exemplary embodiments. In fact, also unexpectedly, during a further exemplary analysis and testing of the present exemplary embodiments, a fluid tight seal was maintained within the junction between two adjacent tubulars despite being bent over 60 degrees relative to one another.

[00180] Thus the present exemplary embodiments will eliminate the need for expensive high precision threaded connection for tubular members in order to provide a fluid tight seal. Instead, a fluid tight seal can now be provided using a combination of less expensive conventional threaded connection and a tubular sleeve that are then radially expanded to provide a fluid tight seal. Thus, the commercial application of the present exemplary embodiments will dramatically reduce the cost of oil and gas exploration and production. Furthermore, the teachings of the present exemplary embodiments can be extended to provide a fluid tight seal between adjacent tubular members in other applications such as, for example, underground pipelines, piping in chemical processing plants, and piping in power plants, in which conventional, inexpensive, piping with conventional threaded connections can be coupled together with a tubular sleeve and then radially expanded to provide an inexpensive and reliable fluid tight seal between the adjacent pipe sections.

[00181] Referring to Figs. 18a and 18b, in an alternative embodiment, a conventional rotary expansion tool 2000 may then lowered into the first and second tubular members, 1900 and 1912, to a position proximate the vicinity of the threads, 1908, 1910, 1920, and 1922. In an exemplary embodiment, the rotary expansion tool 2000 may be, for example, a rotary expansion tool as disclosed in U.S. Patent Application Publication No. US 2001/0045284, published on November 29, 2001, the disclosure of which is incorporated herein by reference.

[00182] As illustrated in Fig. 18b, The rotary expansion tool 2000 may then be controllably increased in size and operated until the outside circumference of the rotary expansion tool engages and radially expands and plastically deforms the end portions of the first and second tubular members, 1900 and 1912, proximate the expansion cone. The rotary expansion tool 2000 may then be displaced in the longitudinal direction 2002 thereby radially expanding and plastically deforming the remaining

portions of the first and second tubular members, 1900 and 1912, in the vicinity of the threads, 1908, 1910, 1920, and 1922. In an exemplary embodiment, the amount of radial expansion is less than about five percent. After completing the radial expansion and plastic deformation of the portion 1942 of the first and second tubular members, 1900 and 1912, in the vicinity of the threads, 1908, 1910, 1920, and 1922, the rotary expansion tool 2000 may then be controllably reduced in size until the outside circumference of the expansion cone disengages from the portion of the second tubular above the portion of the second tubular member in the vicinity of the threads. In this manner, only the portions of the first and second tubular members, 1900 and 1912, in the vicinity of the threads, 1908, 1910, 1920, and 1922, are radially expanded and plastically deformed.

[00183] More generally still, as illustrated in Fig. 19, the teachings of the present exemplary embodiments provide a method 2100 of providing a fluid tight seal between a pair of adjacent tubular members in which the location of a fluid leak may be detected in the junction between a pair of adjacent tubular members in step 2102. In an exemplary embodiment, in step 2102, a pressurized fluid may be injected through the adjacent coupled tubular members and the amount, if any, of any fluid leakage through the junctions between the adjacent tubular members monitored.

[00184] If the amount of fluid leakage through the junctions of the adjacent tubular members exceeds a predetermined amount, then a tubular sleeve may then be coupled to and overlapping the junction between the adjacent tubular members in step 2104. And, finally, in step 2106, the portions of the tubular members proximate the tubular sleeve may then be radially expanded. In this manner, a cost efficient and reliable method for repairing leaks in the junctions between adjacent tubular members may be provided.

[00185] Referring to Fig. 20, in an exemplary embodiment, after radially expanding and plastically deforming the first and second tubular members, 1900 and 1912, and the tubular sleeve 1924, an energy source 2202 may be operably coupled to the second tubular member. The energy source 2202 may include, for example, a source of electrical, acoustic, and/or thermal energy. A controller 2204 may also be operably coupled to the energy source 2202 for controlling the operation of the energy source. In an exemplary embodiment, the first and second tubular members, 1900 and 1912, and the tubular sleeve 1924 are positioned within a borehole 2206 that traverses a subterranean formation 2208, and the energy source 2202 and the controller 2204 are positioned on the surface.

[00186] During operation, electrical, acoustic, and/or thermal energy may then be transmitted through the first and second tubular members, 1900 and 1912, and the tubular sleeve 1924, using the energy source 2202 and controller 2204. In an exemplary embodiment, the first tubular member 1900 may be operably coupled to an earth ground 2206 such as, for example, a subterranean formation. In this manner, the transmission of electrical, acoustic, and/or thermal energy through the tubular members, 1900 and 1912, and the tubular sleeve 1924, may be enhanced. The enhanced coupling of the first and second tubular members, 1900 and 1912, provided by the addition of the tubular sleeve

1924 during the radial expansion process, provides a enhanced conductive pathway for electrical, thermal, and/or acoustic energy.

[00187] In an exemplary embodiment, the transmitted electrical, acoustic, and/or thermal energy may be used, for example, to transmit communication signals to downhole tools, heat the first and second tubular members, 1900 and 1912, and tubular sleeve 1924, and/or to inject energy into the surrounding subterranean formation. In this manner, information may be transmitted through the tubular members, 1900 and 1912, and tubular sleeve 1924 to downhole tools. As will be recognized by persons having ordinary skill in the art, the transmission of an electrical current through the first and second tubular members, 1900 and 1912, will cause resistance heating of the tubular members. In this manner, the surrounding subterranean formation may be heated to thereby facilitate the extraction and recovery of hydrocarbons.

[00188] More generally, the teachings of the exemplary embodiment of Fig. 20 may be applied to one or more of the teachings of the exemplary embodiments of Figs. 1a-19 in order to transmit electrical, acoustic, and/or thermal energy through the corresponding radially expanded and plastically deformed tubular members and sleeves. In particular, the enhanced coupling of the tubular members of the exemplary embodiments of Figs. 1a-19, provided by the addition of the corresponding tubular sleeves during the radial expansion process, provides an enhanced conductive pathway for the transmission of electrical, thermal and/or acoustic energy through the radially expanded tubular members.

[00189] More generally still, the teachings of Fig. 20 may applied to the one or more of the teachings of the exemplary embodiments of Figs. 1a-19 in order to transmit electrical, acoustic, and/or thermal energy through the corresponding tubular members and sleeves, prior to the radial expansion and plastic deformation of the tubular members and sleeves. In particular, the enhanced coupling of the tubular members of the exemplary embodiments of Figs. 1a-19, provided by the addition of the corresponding tubular sleeves, prior to the radial expansion process, provides an enhanced conductive pathway for the transmission of electrical, thermal and/or acoustic energy through the radially expanded tubular members.

[00190] A method of radially expanding and plastically deforming a first tubular member and a second tubular member has been described that includes inserting an end of the first tubular member into an end of a tubular sleeve having an internal flange into abutment with the internal flange, inserting an end of the second tubular member into another end of the tubular sleeve, threadably coupling the ends of the first and second tubular member within the tubular sleeve until both ends of the first and second tubular members abut the internal flange of the tubular sleeve, and displacing an expansion cone through the interiors of the first and second tubular members. In an exemplary embodiment, the internal flange of the tubular sleeve is positioned between the ends of the tubular sleeve. In an exemplary embodiment, the internal flange of the tubular sleeve is positioned at one end

of the tubular sleeve. In an exemplary embodiment, the tubular sleeve further includes one or more sealing members for sealing the interface between the tubular sleeve and at least one of the tubular members. In an exemplary embodiment, the method further includes placing the tubular members in another structure, and displacing the expansion cone through the interiors of the first and second tubular members. In an exemplary embodiment, the method further includes radially expanding the tubular sleeve into engagement with the structure. In an exemplary embodiment, the method further includes sealing an annulus between the tubular sleeve and the other structure. In an exemplary embodiment, the other structure comprises a wellbore. In an exemplary embodiment, the other structure comprises a wellbore casing. In an exemplary embodiment, the tubular sleeve further comprises a sealing element coupled to the exterior of the tubular sleeve. In an exemplary embodiment, the tubular sleeve is metallic. In an exemplary embodiment, the tubular sleeve is non-metallic. In an exemplary embodiment, the tubular sleeve is plastic. In an exemplary embodiment, the tubular sleeve is ceramic. In an exemplary embodiment, the method further includes breaking the tubular sleeve. In an exemplary embodiment, the tubular sleeve includes one or more longitudinal slots. In an exemplary embodiment, the tubular sleeve includes one or more radial passages.

[00191] A method of radially expanding and plastically deforming a first tubular member and a second tubular member has also been described that includes inserting an end of the first tubular member into an end of a tubular sleeve, coupling the end of the tubular sleeve to the end of the first tubular member, inserting an end of the second tubular member into another end of the tubular sleeve, threadably coupling the ends of the first and second tubular member within the tubular sleeve, coupling the other end of the tubular sleeve to the end of the second tubular member, and displacing an expansion cone through the interiors of the first and second tubular members. In an exemplary embodiment, coupling the ends of the tubular sleeve to the ends of the first and second tubular members includes coupling the ends of the tubular sleeve to the ends of the first and second tubular members using locking rings. In an exemplary embodiment, coupling the ends of the tubular sleeve to the ends of the first and second tubular members using locking rings includes wedging the locking rings between the ends of the tubular sleeve and the ends of the first and second tubular members. In an exemplary embodiment, coupling the ends of the tubular sleeve to the ends of the first and second tubular members using locking rings includes affixing the locking rings to the ends of the first and second tubular members. In an exemplary embodiment, the locking rings are resilient. In an exemplary embodiment, the locking rings are elastomeric. In an exemplary embodiment, coupling the ends of the tubular sleeve to the ends of the first and second tubular members includes crimping the ends of the tubular sleeve onto the ends of the first and second tubular members. In an exemplary embodiment, the tubular sleeve further includes one or more sealing members for sealing the interface between the tubular sleeve and at least one of the tubular members. In an exemplary embodiment, the method further includes placing the tubular members in another structure, and displacing the expansion

cone through the interiors of the first and second tubular members. In an exemplary embodiment, the method further includes radially expanding the tubular sleeve into engagement with the structure. In an exemplary embodiment, the method further includes sealing an annulus between the tubular sleeve and the other structure. In an exemplary embodiment, the other structure is a wellbore. In an exemplary embodiment, the other structure is a wellbore casing. In an exemplary embodiment, the tubular sleeve further includes a sealing element coupled to the exterior of the tubular sleeve. In an exemplary embodiment, the tubular sleeve is metallic. In an exemplary embodiment, the tubular sleeve is non-metallic. In an exemplary embodiment, the tubular sleeve is plastic. In an exemplary embodiment, the tubular sleeve is ceramic. In an exemplary embodiment, the method further includes breaking the tubular sleeve. In an exemplary embodiment, the tubular sleeve includes one or more longitudinal slots. In an exemplary embodiment, the tubular sleeve includes one or more radial passages.

[00192] A method of radially expanding and plastically deforming a first tubular member and a second tubular member has also been described that includes inserting an end of a tubular sleeve having an external flange into an end of the first tubular member until the external flange abuts the end of the first tubular member, inserting the other end of the tubular sleeve into an end of a second tubular member, threadably coupling the ends of the first and second tubular member within the tubular sleeve until both ends of the first and second tubular members abut the external flange of the tubular sleeve, and displacing an expansion cone through the interiors of the first and second tubular members. In an exemplary embodiment, the external flange of the tubular sleeve is positioned between the ends of the tubular sleeve. In an exemplary embodiment, the external flange of the tubular sleeve is positioned at one end of the tubular sleeve. In an exemplary embodiment, the tubular sleeve further includes one or more sealing members for sealing the interface between the tubular sleeve and at least one of the tubular members. In an exemplary embodiment, the method further includes placing the tubular members in another structure, and displacing the expansion cone through the interiors of the first and second tubular members. In an exemplary embodiment, the other structure comprises a wellbore. In an exemplary embodiment, the other structure comprises a wellbore casing. In an exemplary embodiment, the tubular sleeve is metallic. In an exemplary embodiment, the tubular sleeve is non-metallic. In an exemplary embodiment, the tubular sleeve is plastic. In an exemplary embodiment, the tubular sleeve is ceramic. In an exemplary embodiment, the method further includes breaking the tubular sleeve. In an exemplary embodiment, the tubular sleeve includes one or more longitudinal slots. In an exemplary embodiment, the tubular sleeve includes one or more radial passages.

[00193] A method of radially expanding and plastically deforming a first tubular member and a second tubular member has also been described that includes inserting an end of the first tubular member into an end of a tubular sleeve having an internal flange into abutment with the internal flange, inserting an end of the second tubular member into another end of the tubular sleeve into abutment

with the internal flange, coupling the ends of the first and second tubular member to the tubular sleeve, and displacing an expansion cone through the interiors of the first and second tubular members. In an exemplary embodiment, the internal flange of the tubular sleeve is positioned between the ends of the tubular sleeve. In an exemplary embodiment, the internal flange of the tubular sleeve is positioned at one end of the tubular sleeve. In an exemplary embodiment, the tubular sleeve further comprises one or more sealing members for sealing the interface between the tubular sleeve and at least one of the tubular members. In an exemplary embodiment, the method further includes placing the tubular members in another structure, and displacing the expansion cone through the interiors of the first and second tubular members. In an exemplary embodiment, the method further includes radially expanding the tubular sleeve into engagement with the structure. In an exemplary embodiment, the method further includes sealing an annulus between the tubular sleeve and the other structure. In an exemplary embodiment, the other structure is a wellbore. In an exemplary embodiment, the other structure is a wellbore casing. In an exemplary embodiment, the tubular sleeve further includes a sealing element coupled to the exterior of the tubular sleeve. In an exemplary embodiment, the tubular sleeve is metallic. In an exemplary embodiment, the tubular sleeve is non-metallic. In an exemplary embodiment, the tubular sleeve is plastic. In an exemplary embodiment, the tubular sleeve is ceramic. In an exemplary embodiment, the method further includes breaking the tubular sleeve. In an exemplary embodiment, the tubular sleeve includes one or more longitudinal slots. In an exemplary embodiment, the tubular sleeve includes one or more radial passages. In an exemplary embodiment, coupling the ends of the first and second tubular member to the tubular sleeve includes heating the tubular sleeve and inserting the ends of the first and second tubular members into the tubular sleeve. In an exemplary embodiment, coupling the ends of the first and second tubular member to the tubular sleeve includes coupling the tubular sleeve to the ends of the first and second tubular members using a locking ring.

[00194] A method has been described that includes coupling an end of a first tubular member to an end of a tubular sleeve, coupling an end of a second tubular member to another end of the tubular sleeve, coupling the ends of the first and second tubular members, and radially expanding and plastically deforming the first tubular member and the second tubular member. In an exemplary embodiment, the tubular sleeve includes an internal flange. In an exemplary embodiment, coupling the end of the first tubular member to the end of the tubular sleeve includes inserting the end of the first tubular member into the end of the tubular sleeve into abutment with the internal flange. In an exemplary embodiment, coupling the end of the second tubular member to the other end of the tubular sleeve includes inserting the end of the second tubular member into the other end of the tubular sleeve into abutment with the internal flange. In an exemplary embodiment, coupling the end of the second tubular member to the other end of the tubular sleeve includes inserting the end of the second tubular member into the other end of the tubular sleeve into abutment with the internal flange. In an

exemplary embodiment, the tubular sleeve includes an external flange. In an exemplary embodiment, coupling the end of the first tubular member to the end of the tubular sleeve includes inserting the end of the tubular sleeve into the end of the first tubular member until the end of the first tubular member abuts the external flange. In an exemplary embodiment, coupling the end of the second tubular member to the other end of the tubular sleeve includes inserting the other end of the tubular sleeve into the end of the second tubular member until the end of the second tubular member abuts the external flange. In an exemplary embodiment, coupling the end of the second tubular member to the other end of the tubular sleeve includes inserting the other end of the tubular sleeve into the end of the second tubular member until the end of the second tubular member abuts the external flange. In an exemplary embodiment, coupling the end of the first tubular member to the end of the tubular sleeve includes inserting a retaining ring between the end of the first tubular member and the end of the tubular sleeve. In an exemplary embodiment, coupling the end of the second tubular member to the other end of the tubular sleeve includes inserting another retaining ring between the end of the second tubular member and the other end of the tubular sleeve. In an exemplary embodiment, coupling the end of the second tubular member to the other end of the tubular sleeve includes inserting a retaining ring between the end of the first tubular member and the other end of the tubular sleeve. In an exemplary embodiment, the retaining ring is resilient. In an exemplary embodiment, the retaining ring and the other retaining ring are resilient. In an exemplary embodiment, the retaining ring is resilient. In an exemplary embodiment, coupling the end of the first tubular member to the end of the tubular sleeve includes deforming the end of the tubular sleeve. In an exemplary embodiment, coupling the end of the second tubular member to the other end of the tubular sleeve includes deforming the other end of the tubular sleeve. In an exemplary embodiment, coupling the end of the second tubular member to the other end of the tubular sleeve includes deforming the other end of the tubular sleeve. In an exemplary embodiment, coupling the end of the first tubular member to the end of the tubular sleeve includes coupling a retaining ring to the end of the first tubular member. In an exemplary embodiment, coupling the end of the second tubular member to the other end of the tubular sleeve includes coupling another retaining ring to the end of the second tubular member. In an exemplary embodiment, coupling the end of the second tubular member to the other end of the tubular sleeve includes coupling a retaining ring to the end of the second tubular member. In an exemplary embodiment, the retaining ring is resilient. In an exemplary embodiment, the retaining ring and the other retaining ring are resilient. In an exemplary embodiment, the retaining ring is resilient. In an exemplary embodiment, coupling the end of the first tubular member to the end of the tubular sleeve includes heating the end of the tubular sleeve, and inserting the end of the first tubular member into the end of the tubular sleeve. In an exemplary embodiment, coupling the end of the second tubular member to the other end of the tubular sleeve includes heating the other end of the tubular sleeve, and inserting the end of the second tubular member into the other end of the tubular sleeve. In an exemplary embodiment, coupling the

end of the second tubular member to the other end of the tubular sleeve includes heating the other end of the tubular sleeve, and inserting the end of the second tubular member into the other end of the tubular sleeve. In an exemplary embodiment, coupling the end of the first tubular member to the end of the tubular sleeve includes inserting the end of the first tubular member into the end of the tubular sleeve, and latching the end of the first tubular member to the end of the tubular sleeve. In an exemplary embodiment, coupling the end of the second tubular member to the other end of the tubular sleeve includes inserting the end of the second tubular member into the end of the tubular sleeve, and latching the end of the second tubular member to the other end of the tubular sleeve. In an exemplary embodiment, coupling the end of the second tubular member to the other end of the tubular sleeve includes inserting the end of the second tubular member into the end of the tubular sleeve, and latching the end of the second tubular member to the other end of the tubular sleeve. In an exemplary embodiment, the tubular sleeve further comprises one or more sealing members for sealing the interface between the tubular sleeve and at least one of the tubular members. In an exemplary embodiment, the method further includes placing the tubular members in another structure, and then radially expanding and plastically deforming the first tubular member and the second tubular member. In an exemplary embodiment, the method further includes radially expanding the tubular sleeve into engagement with the structure. In an exemplary embodiment, the method further includes sealing an annulus between the tubular sleeve and the other structure. In an exemplary embodiment, the other structure is a wellbore. In an exemplary embodiment, the other structure is a wellbore casing. In an exemplary embodiment, the tubular sleeve further includes a sealing element coupled to the exterior of the tubular sleeve. In an exemplary embodiment, the tubular sleeve is metallic. In an exemplary embodiment, the tubular sleeve is non-metallic. In an exemplary embodiment, the tubular sleeve is plastic. In an exemplary embodiment, the tubular sleeve is ceramic. In an exemplary embodiment, the method further includes breaking the tubular sleeve. In an exemplary embodiment, the tubular sleeve includes one or more longitudinal slots. In an exemplary embodiment, the tubular sleeve includes one or more radial passages. In an exemplary embodiment, radially expanding and plastically deforming the first tubular member, the second tubular member, and the tubular sleeve includes displacing an expansion cone within and relative to the first and second tubular members. In an exemplary embodiment, radially expanding and plastically deforming the first tubular member, the second tubular member, and the tubular sleeve includes applying radial pressure to the interior surfaces of the first and second tubular member using a rotating member. In an exemplary embodiment, the method further includes amorphously bonding the first and second tubular members during the radial expansion and plastic deformation of the first and second tubular members. In an exemplary embodiment, the method further includes welding the first and second tubular members during the radial expansion and plastic deformation of the first and second tubular members. In an exemplary embodiment, the method further includes providing a fluid tight seal within the threaded coupling between the first and second tubular

members during the radial expansion and plastic deformation of the first and second tubular members. In an exemplary embodiment, the method further includes placing the tubular sleeve in circumferential tension, placing the end of the first tubular member in circumferential compression, and placing the end of the second tubular member in circumferential compression. In an exemplary embodiment, the method further includes placing the tubular sleeve in circumferential compression, placing the end of the first tubular member in circumferential tension, and placing the end of the second tubular member in circumferential tension. In an exemplary embodiment, radially expanding and plastically deforming the first tubular member and the second tubular member includes radially expanding and plastically deforming only the portions of the first and second members proximate the tubular sleeve. In an exemplary embodiment, the method further includes providing a fluid tight seal between the tubular sleeve and at least one of the first and second tubular members. In an exemplary embodiment, the first tubular member includes internal threads, and the second tubular member includes external threads that engage the internal threads of the first tubular member. In an exemplary embodiment, radially expanding and plastically deforming the first tubular member and the second tubular member includes radially expanding and plastically deforming only the portions of the first and second members proximate the threads of the first and second tubular members. In an exemplary embodiment, the method further includes providing a fluid tight seal between the threads of the first and second tubular members. In an exemplary embodiment, the method further includes providing a fluid tight seal between the tubular sleeve and at least one of the first and second tubular members. In an exemplary embodiment, the first and second tubular members are wellbore casings. In an exemplary embodiment, the first and second tubular members are pipes.

[00195] A method has been described that includes providing a tubular sleeve including an internal flange positioned between the ends of the tubular sleeve, inserting an end of a first tubular member into an end of the tubular sleeve into abutment with the internal flange, inserting an end of a second tubular member into another end of the tubular sleeve into abutment the internal flange, threadably coupling the ends of the first and second tubular members, radially expanding and plastically deforming the first tubular member and the second tubular member, placing the tubular sleeve in circumferential tension, placing the end of the first tubular member in circumferential compression, and placing the end of the second tubular member in circumferential compression.

[00196] A method has been described that includes providing a tubular sleeve including an external flange positioned between the ends of the tubular sleeve, inserting an end of the tubular sleeve into an end of a first tubular member until the end of the first tubular member abuts with the external flange, inserting another end of the tubular sleeve into an end of the second tubular member until the end of the second tubular member abuts the external flange, threadably coupling the ends of the first and second tubular members, radially expanding and plastically deforming the first tubular member and the second tubular member, placing the tubular sleeve in circumferential compression, placing the

end of the first tubular member in circumferential tension, and placing the end of the second tubular member in circumferential tension.

[00197] A method has been described that includes providing a tubular sleeve including an internal flange positioned between the ends of the tubular sleeve, inserting an end of a first tubular member into an end of the tubular sleeve into abutment with the internal flange, inserting an end of a second tubular member into another end of the tubular sleeve into abutment the internal flange, threadably coupling the ends of the first and second tubular members, radially expanding and plastically deforming only the portions of the first tubular member and the second tubular member proximate the threads of the first and second tubular members, placing the tubular sleeve in circumferential tension, placing the end of the first tubular member in circumferential compression, and placing the end of the second tubular member in circumferential compression.

[00198] A method has been described that includes providing a tubular sleeve including an external flange positioned between the ends of the tubular sleeve, inserting an end of the tubular sleeve into an end of a first tubular member until the end of the first tubular member abuts with the external flange, inserting another end of the tubular sleeve into an end of the second tubular member until the end of the second tubular member abuts the external flange, threadably coupling the ends of the first and second tubular members, radially expanding and plastically deforming only the portions of the first tubular member and the second tubular member proximate the threads of the first and second tubular members, placing the tubular sleeve in circumferential compression, placing the end of the first tubular member in circumferential tension, and placing the end of the second tubular member in circumferential tension.

[00199] An apparatus has been described that includes a tubular sleeve, a first tubular member coupled to an end of the tubular sleeve, and a second tubular member coupled to another end of the tubular sleeve. In an exemplary embodiment, the tubular sleeve is in circumferential tension, the end portion of the first tubular member is in circumferential compression, and the end portion of the second tubular member is in circumferential compression. In an exemplary embodiment, the tubular sleeve is in circumferential compression, the end portion of the first tubular member is in circumferential tension, and the end portion of the second tubular member is in circumferential tension. In an exemplary embodiment, the tubular sleeve includes an internal flange. In an exemplary embodiment, the end portion of the first tubular member is received within an end of the tubular sleeve, and the end portion of the second tubular member is received within another end of the tubular sleeve. In an exemplary embodiment, the end portions of the first and second tubular members abut the internal flange of the tubular sleeve. In an exemplary embodiment, the end portion of the first tubular member is received within an end of the tubular sleeve. In an exemplary embodiment, the end portions of the first and second tubular members abut the internal flange of the tubular sleeve. In an exemplary embodiment, the end portion of the second tubular member is received within an end of the tubular

sleeve. In an exemplary embodiment, the end portions of the first and second tubular members abut the internal flange of the tubular sleeve. In an exemplary embodiment, the internal flange of the tubular sleeve is positioned between the ends of the tubular sleeve. In an exemplary embodiment, the internal flange of the tubular sleeve is positioned at an end of the tubular sleeve. In an exemplary embodiment, the tubular sleeve includes an external flange. In an exemplary embodiment, an end portion of the tubular sleeve is received within the first tubular member; and another end portion of the tubular sleeve is received within the end portion of the second tubular member. In an exemplary embodiment, the end portions of the first and second tubular members abut the external flange of the tubular sleeve. In an exemplary embodiment, an end portion of the tubular sleeve is received within the end portion of the first tubular member. In an exemplary embodiment, the end portions of the first and second tubular members abut the external flange of the tubular sleeve. In an exemplary embodiment, an end portion of the tubular sleeve is received within the end portion of the second tubular member. In an exemplary embodiment, the end portions of the first and second tubular members abut the external flange of the tubular sleeve. In an exemplary embodiment, the external flange of the tubular sleeve is positioned between the ends of the tubular sleeve. In an exemplary embodiment, the external flange of the tubular sleeve is positioned at an end of the tubular sleeve. In an exemplary embodiment, the tubular sleeve further comprises one or more sealing members for sealing the interface between the tubular sleeve and at least one of the tubular members. In an exemplary embodiment, the apparatus further includes a retaining ring positioned between the end of the first tubular member and the end of the tubular sleeve. In an exemplary embodiment, the apparatus further includes another retaining ring positioned between the end of the second tubular member and the other end of the tubular sleeve. In an exemplary embodiment, the apparatus further includes a retaining ring positioned between the end of the first tubular member and the other end of the tubular sleeve. In an exemplary embodiment, the retaining ring is resilient. In an exemplary embodiment, the retaining ring and the other retaining ring are resilient. In an exemplary embodiment, the retaining ring is resilient. In an exemplary embodiment, the end of the tubular sleeve is deformed onto the end of the first tubular member. In an exemplary embodiment, the other end of the tubular sleeve is deformed onto the end of the second tubular member. In an exemplary embodiment, the other end of the tubular sleeve is deformed onto the end of the second tubular member. In an exemplary embodiment, the apparatus further includes a retaining ring coupled to the end of the first tubular member for retaining the tubular sleeve onto the end of the first tubular member. In an exemplary embodiment, the apparatus further includes another retaining ring coupled to the end of the second tubular member for retaining the other end of the tubular sleeve onto the end of the second tubular member. In an exemplary embodiment, the apparatus further includes a retaining ring coupled to the end of the second tubular member for retaining the other end of the tubular sleeve onto the end of the second tubular member. In an exemplary embodiment, the retaining ring is resilient. In an exemplary embodiment,

the retaining ring and the other retaining ring are resilient. In an exemplary embodiment, the retaining ring is resilient. In an exemplary embodiment, the apparatus further includes a locking ring for coupling the end of the first tubular member to the end of the tubular sleeve. In an exemplary embodiment, the apparatus further includes another locking ring for coupling the end of the second tubular member to the other end of the tubular sleeve. In an exemplary embodiment, the apparatus further includes a locking ring for coupling the end of the second tubular member to the other end of the tubular sleeve. In an exemplary embodiment, the apparatus further includes a structure for receiving the first and second tubular members and the tubular sleeve, and the tubular sleeve contacts the interior surface of the structure. In an exemplary embodiment, the tubular sleeve further includes a sealing member for fluidicly sealing the interface between the tubular sleeve and the structure. In an exemplary embodiment, the other structure is a wellbore. In an exemplary embodiment, the other structure is a wellbore casing. In an exemplary embodiment, the tubular sleeve further includes a sealing element coupled to the exterior surface of the tubular sleeve. In an exemplary embodiment, the tubular sleeve is metallic. In an exemplary embodiment, the tubular sleeve is non-metallic. In an exemplary embodiment, the tubular sleeve is plastic. In an exemplary embodiment, the tubular sleeve is ceramic. In an exemplary embodiment, the tubular sleeve is frangible. In an exemplary embodiment, the tubular sleeve includes one or more longitudinal slots. In an exemplary embodiment, the tubular sleeve includes one or more radial passages. In an exemplary embodiment, the first and second tubular members are amorphously bonded. In an exemplary embodiment, the first and second tubular members are welded. In an exemplary embodiment, the internal threads of the first tubular member and the internal threads of the second tubular member together provide a fluid tight seal. In an exemplary embodiment, only the portions of the first and second tubular members proximate the tubular sleeve are plastically deformed. In an exemplary embodiment, a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members. In an exemplary embodiment, the first tubular member includes internal threads; and wherein the second tubular member includes external threads that engage the internal threads of the first tubular member. In an exemplary embodiment, only the portions of the first and second members proximate the threads of the first and second tubular members are plastically deformed. In an exemplary embodiment, a fluid tight seal is provided between the threads of the first and second tubular members. In an exemplary embodiment, a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members.

[00200] An apparatus has been described that includes a tubular sleeve including an internal flange positioned between the ends of the tubular sleeve, a first tubular member received within an end of the tubular sleeve in abutment with the internal flange that comprises internal threads, and a second tubular member received within another end of the tubular sleeve in abutment with the internal flange that comprises external threads that engage the internal threads of the first tubular member. The tubular

sleeve is in circumferential tension, the end of first tubular member is in circumferential compression, and the end of the second tubular member is in circumferential compression.

[00201] An apparatus has been described that includes a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve, a first tubular member that receives an end of the tubular sleeve and abuts the external flange that comprises internal threads, and a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first tubular member. The tubular sleeve is in circumferential compression, the first tubular member is in circumferential tension, and the second tubular member is in circumferential tension.

[00202] An apparatus has been described that includes a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve, a first tubular member received within an end of the tubular sleeve in abutment with the internal flange that comprises internal threads, and a second tubular member received within another end of the tubular sleeve in abutment with the internal flange that comprises external threads that engage the internal threads of the first tubular member. The tubular sleeve is in circumferential tension, the end of first tubular member is in circumferential compression, the end of the second tubular member is in circumferential compression, a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members, and a fluid tight seal is provided between the threads of the first and second tubular members.

[00203] An apparatus has been described that includes a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve, a first tubular member that receives an end of the tubular sleeve and abuts the external flange that comprises internal threads, and a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first tubular member. The tubular sleeve is in circumferential compression, the first tubular member is in circumferential tension, the second tubular member is in circumferential tension, a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members, and a fluid tight seal is provided between the threads of the first and second tubular members.

[00204] A method of extracting geothermal energy from a subterranean source of geothermal energy has been described that includes drilling a borehole that traverses the subterranean source of geothermal energy, positioning a first casing string within the borehole, radially expanding and plastically deforming the first casing string within the borehole, positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy, overlapping a portion of the second casing string with a portion of the first casing string, radially expanding and plastically deforming the second casing string within the borehole, and extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings. In an exemplary embodiment, the interior diameter of a passage defined by the first and second casing strings is

constant. In an exemplary embodiment, at least one of the first and second casing strings includes a tubular sleeve, a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion, and a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member.

[00205] A method of extracting geothermal energy from a subterranean source of geothermal energy has been described that includes drilling a borehole that traverses the subterranean source of geothermal energy, positioning a first casing string within the borehole, radially expanding and plastically deforming the first casing string within the borehole, positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy, overlapping a portion of the second casing string with a portion of the first casing string, radially expanding and plastically deforming the second casing string within the borehole, and extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings. the interior diameter of a passage defined by the first and second casing strings is constant, and at least one of the first and second casing strings includes a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve, a first tubular member received within an end of the tubular sleeve in abutment with the internal flange that comprises internal threads, and a second tubular member received within another end of the tubular sleeve in abutment with the internal flange that comprises external threads that engage the internal threads of the first tubular member.

[00206] A method of extracting geothermal energy from a subterranean source of geothermal energy has been described that includes drilling a borehole that traverses the subterranean source of geothermal energy, positioning a first casing string within the borehole, radially expanding and plastically deforming the first casing string within the borehole, positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy, overlapping a portion of the second casing string with a portion of the first casing string, radially expanding and plastically deforming the second casing string within the borehole, and extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings. The interior diameter of a passage defined by the first and second casing strings is constant, and at least one of the first and second casing strings include: a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve, a first tubular member that receives an end of the tubular sleeve that abuts external flange that comprises internal threads, and a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first tubular member.

[00207] A method of extracting geothermal energy from a subterranean source of geothermal energy has been described that includes drilling a borehole that traverses the subterranean source of geothermal energy, positioning a first casing string within the borehole, radially expanding and

plastically deforming the first casing string within the borehole, positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy, overlapping a portion of the second casing string with a portion of the first casing string, radially expanding and plastically deforming the second casing string within the borehole, and extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings. The interior diameter of a passage defined by the first and second casing strings is constant, and at least one of the first and second casing strings include a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve, a first tubular member received within an end of the tubular sleeve in abutment with the internal flange that comprises internal threads, and a second tubular member received within another end of the tubular sleeve in abutment with the internal flange that comprises external threads that engage the internal threads of the first tubular member. The tubular sleeve is in circumferential tension, the first tubular member is in circumferential compression, the second tubular member is in circumferential compression, a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members, and a fluid tight seal is provided between the threads of the first and second tubular members.

[00208] A method of extracting geothermal energy from a subterranean source of geothermal energy has been described that includes drilling a borehole that traverses the subterranean source of geothermal energy, positioning a first casing string within the borehole, radially expanding and plastically deforming the first casing string within the borehole, positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy, overlapping a portion of the second casing string with a portion of the first casing string, radially expanding and plastically deforming the second casing string within the borehole, and extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings. The interior diameter of a passage defined by the first and second casing strings is constant, and wherein at least one of the first and second casing strings include a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve, a first tubular member that receives an end of the tubular sleeve that abuts external flange that comprises internal threads, and a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first tubular member. The tubular sleeve is in circumferential compression, the first tubular member is in circumferential tension, the second tubular member is in circumferential tension, a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members, and a fluid tight seal is provided between the threads of the first and second tubular members.

[00209] An apparatus for extracting geothermal energy from a subterranean source of geothermal energy has been described that includes a borehole that traverses the subterranean source of geothermal energy, a first casing string positioned within the borehole, and a second casing positioned within the

borehole that overlaps with the first casing string that traverses the subterranean source of geothermal energy. The first casing string and the second casing string are radially expanded and plastically deformed within the borehole. In an exemplary embodiment, the interior diameter of a passage defined by the first and second casing strings is constant. In an exemplary embodiment, at least one of the first and second casing strings include a tubular sleeve, a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion, and a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member.

[00210] An apparatus for extracting geothermal energy from a subterranean source of geothermal energy has been described that includes a borehole that traverses the subterranean source of geothermal energy, a first casing string positioned within the borehole, a second casing string within the borehole that traverses the subterranean source of geothermal energy that overlaps with the first casing string. The first and second casing strings are radially expanded and plastically deformed within the borehole, the inside diameter of a passage defined by the first and second casing strings is constant, and at least one of the first and second casing strings includes a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve, a first tubular member received within an end of the tubular sleeve in abutment with the internal flange that comprises internal threads, and a second tubular member received within another end of the tubular sleeve in abutment with the internal flange that comprises external threads that engage the internal threads of the first tubular member.

[00211] An apparatus for extracting geothermal energy from a subterranean source of geothermal energy has been described a borehole that traverses the subterranean source of geothermal energy, a first casing string positioned within the borehole, and a second casing string positioned within the borehole that traverses the subterranean source of geothermal energy that overlaps with the first casing string. The interior diameter of a passage defined by the first and second casing strings is constant, and wherein at least one of the first and second casing strings include: a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve, a first tubular member that receives an end of the tubular sleeve that abuts external flange that comprises internal threads, and a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first tubular member.

[00212] An apparatus for extracting geothermal energy from a subterranean source of geothermal energy has been described that includes a borehole that traverses the subterranean source of geothermal energy, a first casing string positioned within the borehole, and a second casing string within the borehole that traverses the subterranean source of geothermal energy that overlaps with the first casing string. The first and second casing strings are radially expanded and plastically deformed within the borehole. The inside diameter of a passage defined by the first and second casing strings is constant, and at least one of the first and second casing strings include: a tubular sleeve comprising an internal

flange positioned between the ends of the tubular sleeve, a first tubular member received within an end of the tubular sleeve in abutment with the internal flange that comprises internal threads, a second tubular member received within another end of the tubular sleeve in abutment with the internal flange that comprises external threads that engage the internal threads of the first tubular member, the tubular sleeve is in circumferential tension, the first tubular member is in circumferential compression, the second tubular member is in circumferential compression, a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members, and a fluid tight seal is provided between the threads of the first and second tubular members.

[00213] An apparatus for extracting geothermal energy from a subterranean source of geothermal energy has been described that includes a borehole that traverses the subterranean source of geothermal energy, a first casing string positioned within the borehole, and a second casing string positioned within the borehole that traverses the subterranean source of geothermal energy that overlaps with the first casing string. The interior diameter of a passage defined by the first and second casing strings is constant, and at least one of the first and second casing strings include: a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve, a first tubular member that receives an end of the tubular sleeve that abuts external flange that comprises internal threads, and a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first tubular member. The tubular sleeve is in circumferential compression, the first tubular member is in circumferential tension, the second tubular member is in circumferential tension, a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members, and a fluid tight seal is provided between the threads of the first and second tubular members.

[00214] A method has been described that includes coupling an end of a first tubular member to an end of a tubular sleeve, coupling an end of a second tubular member to another end of the tubular sleeve, coupling the ends of the first and second tubular members, injecting a pressurized fluid through the first and second tubular members, determining if any of the pressurized fluid leaks through the coupled ends of the first and second tubular members, and if a predetermined amount of the pressurized fluid leaks through the coupled ends of the first and second tubular members, then coupling a tubular sleeve to the ends of the first and second tubular members and radially expanding and plastically deforming only the portions of the first and second tubular members proximate the tubular sleeve. In an exemplary embodiment, radially expanding and plastically deforming only the portions of the first and second tubular members proximate the tubular sleeve includes displacing an expansion cone within and relative to the first and second tubular members. In an exemplary embodiment, radially expanding and plastically deforming only the portions of the first and second tubular members proximate the tubular sleeve includes applying radial pressure to the interior surfaces of the first and second tubular member proximate the tubular sleeve using a rotating member.

[00215] A method has been described that includes coupling an end of a first tubular member to an end of a tubular sleeve, coupling an end of a second tubular member to another end of the tubular sleeve, coupling the ends of the first and second tubular members, radially expanding and plastically deforming the first tubular member and the second tubular member, and transmitting energy through the first and second tubular members. In an exemplary embodiment, the energy is electrical energy. In an exemplary embodiment, the electrical energy is a communication signal. In an exemplary embodiment, the energy is thermal energy. In an exemplary embodiment, the energy is acoustic energy. In an exemplary embodiment, the energy is transmitted through the first and second tubular members prior to radially expanding and plastically deforming the first and second tubular members. In an exemplary embodiment, the energy is transmitted through the first and second tubular members after radially expanding and plastically deforming the first and second tubular members. In an exemplary embodiment, the method further includes placing the tubular members in another structure, then radially expanding the tubular members, and transmitting energy through the first and second tubular members.

[00216] A system has been described that includes a source of energy, a borehole formed in the earth, a first tubular member positioned within the borehole operably coupled to the source of energy, a second tubular member positioned within the borehole coupled to the first tubular member, and a tubular sleeve positioned within the borehole coupled to the first and second tubular members. The first tubular member, second tubular member, and the tubular sleeve are plastically deformed into engagement with one another. In an exemplary embodiment, the source of energy is a source of electrical energy. In an exemplary embodiment, the source of energy is a source of thermal energy. In an exemplary embodiment, the source of energy is a source of acoustic energy.

[00217] A method of operating a well for extracting hydrocarbons from a subterranean formation has been described that includes drilling a borehole into the earth that traverses the subterranean formation, positioning a wellbore casing in the borehole, transmitting energy through the wellbore casing, and extracting hydrocarbons from the subterranean formation. The wellbore casing includes a first tubular member, a second tubular member coupled to the first tubular member, and a tubular sleeve coupled to the first and second tubular member. The first tubular member, the second tubular member, and the tubular sleeve are plastically deformed into engagement with one another. In an exemplary embodiment, the energy is electrical energy. In an exemplary embodiment, the energy is thermal energy. In an exemplary embodiment, the energy is acoustic energy.

[00218] It is understood that variations may be made in the foregoing without departing from the scope of the invention. For example, the teachings of the present illustrative embodiments may be used to provide a wellbore casing, a pipeline, or a structural support. Furthermore, the elements and teachings of the various illustrative embodiments may be combined in whole or in part in some or all of the illustrative embodiments.

[00219] Although illustrative embodiments of the invention have been shown and described, a wide range of modification, changes and substitution is contemplated in the foregoing disclosure. In some instances, some features of the present invention may be employed without a corresponding use of the other features. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the scope of the invention.

Claims

What is claimed is:

1. A method, comprising:
   coupling an end of a first tubular member to an end of a tubular sleeve;
   coupling an end of a second tubular member to another end of the tubular sleeve;
   coupling the ends of the first and second tubular members; and
   radially expanding and plastically deforming the first tubular member and the second tubular member.
2. The method of claim 1, wherein the tubular sleeve comprises an internal flange.
3. The method of claim 2, wherein coupling the end of the first tubular member to the end of the tubular sleeve comprises:
   inserting the end of the first tubular member into the end of the tubular sleeve into abutment with the internal flange.
4. The method of claim 3, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:
   inserting the end of the second tubular member into the other end of the tubular sleeve into abutment with the internal flange.
5. The method of claim 2, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:
   inserting the end of the second tubular member into the other end of the tubular sleeve into abutment with the internal flange.
6. The method of claim 1, wherein the tubular sleeve comprises an external flange.
7. The method of claim 6, wherein coupling the end of the first tubular member to the end of the tubular sleeve comprises:
   inserting the end of the tubular sleeve into the end of the first tubular member until the end of the first tubular member abuts the external flange.
8. The method of claim 7, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:
   inserting the other end of the tubular sleeve into the end of the second tubular member until the end of the second tubular member abuts the external flange.
9. The method of claim 6, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:
   inserting the other end of the tubular sleeve into the end of the second tubular member until the end of the second tubular member abuts the external flange.

10. The method of claim 1, wherein coupling the end of the first tubular member to the end of the tubular sleeve comprises:

inserting a retaining ring between the end of the first tubular member and the end of the tubular sleeve.

11. The method of claim 10, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

inserting another retaining ring between the end of the second tubular member and the other end of the tubular sleeve.

12. The method of claim 1, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

inserting a retaining ring between the end of the first tubular member and the other end of the tubular sleeve.

13. The method of claim 10, wherein the retaining ring is resilient.

14. The method of claim 11, wherein the retaining ring and the other retaining ring are resilient.

15. The method of claim 12, wherein the retaining ring is resilient.

16. The method of claim 1, wherein coupling the end of the first tubular member to the end of the tubular sleeve comprises:

deforming the end of the tubular sleeve.

17. The method of claim 16, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

deforming the other end of the tubular sleeve.

18. The method of claim 1, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

deforming the other end of the tubular sleeve.

19. The method of claim 1, wherein coupling the end of the first tubular member to the end of the tubular sleeve comprises:

coupling a retaining ring to the end of the first tubular member.

20. The method of claim 19, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

coupling another retaining ring to the end of the second tubular member.

21. The method of claim 1, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

coupling a retaining ring to the end of the second tubular member.

22. The method of claim 19, wherein the retaining ring is resilient.

23. The method of claim 20, wherein the retaining ring and the other retaining ring are resilient.

24. The method of claim 21, wherein the retaining ring is resilient.

25. The method of claim 1, wherein coupling the end of the first tubular member to the end of the tubular sleeve comprises:

heating the end of the tubular sleeve; and

inserting the end of the first tubular member into the end of the tubular sleeve.

26. The method of claim 25, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

heating the other end of the tubular sleeve; and

inserting the end of the second tubular member into the other end of the tubular sleeve.

27. The method of claim 1, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

heating the other end of the tubular sleeve; and

inserting the end of the second tubular member into the other end of the tubular sleeve.

28. The method of claim 1, wherein coupling the end of the first tubular member to the end of the tubular sleeve comprises:

inserting the end of the first tubular member into the end of the tubular sleeve; and

latching the end of the first tubular member to the end of the tubular sleeve.

29. The method of claim 28, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

inserting the end of the second tubular member into the end of the tubular sleeve; and

latching the end of the second tubular member to the other end of the tubular sleeve.

30. The method of claim 1, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

inserting the end of the second tubular member into the end of the tubular sleeve; and

latching the end of the second tubular member to the other end of the tubular sleeve.

31. The method of claim 1, wherein the tubular sleeve further comprises one or more sealing members for sealing the interface between the tubular sleeve and at least one of the tubular members.

32. The method of claim 1, further comprising:

placing the tubular members in another structure; and

then radially expanding and plastically deforming the first tubular member and the second tubular member.

33. The method of claim 32, further comprising:

radially expanding the tubular sleeve into engagement with the structure.

34. The method of claim 32, further comprising:

sealing an annulus between the tubular sleeve and the other structure.

35. The method of claim 32, wherein the other structure comprises a wellbore.

36. The method of claim 32, wherein the other structure comprises a wellbore casing.

37. The method of claim 1, wherein the tubular sleeve further comprises a sealing element coupled to the exterior of the tubular sleeve.

38. The method of claim 1, wherein the tubular sleeve is metallic.

39. The method of claim 1, wherein the tubular sleeve is non-metallic.

40. The method of claim 1, wherein the tubular sleeve is plastic.

41. The method of claim 1, wherein the tubular sleeve is ceramic..

42. The method of claim 1, further comprising:

breaking the tubular sleeve.

43. The method of claim 1, wherein the tubular sleeve includes one or more longitudinal slots.

44. The method of claim 1, wherein the tubular sleeve includes one or more radial passages.

45. The method of claim 1, wherein radially expanding and plastically deforming the first tubular member, the second tubular member, and the tubular sleeve comprises:

displacing an expansion cone within and relative to the first and second tubular members.

46. The method of claim 1, wherein radially expanding and plastically deforming the first tubular member, the second tubular member, and the tubular sleeve comprises:

applying radial pressure to the interior surfaces of the first and second tubular member using a rotating member.

47. The method of claim 1, further comprising:

amorphously bonding the first and second tubular members during the radial expansion and plastic deformation of the first and second tubular members.

48. The method of claim 1, further comprising:

welding the first and second tubular members during the radial expansion and plastic deformation of the first and second tubular members..

49. The method of claim 1, further comprising:

providing a fluid tight seal within the threaded coupling between the first and second tubular members during the radial expansion and plastic deformation of the first and second tubular members.

50. The method of claim 1, further comprising:

placing the tubular sleeve in circumferential tension;

placing the end of the first tubular member in circumferential compression; and

placing the end of the second tubular member in circumferential compression.

51. The method of claim 1, further comprising:

placing the tubular sleeve in circumferential compression;

placing the end of the first tubular member in circumferential tension; and

placing the end of the second tubular member in circumferential tension.

52. The method of claim 1, wherein radially expanding and plastically deforming the first tubular

member and the second tubular member comprises:

radially expanding and plastically deforming only the portions of the first and second members proximate the tubular sleeve.

53. The method of claim 52, further comprising:

providing a fluid tight seal between the tubular sleeve and at least one of the first and second tubular members.

54. The method of claim 1, wherein the first tubular member comprises internal threads; and wherein the second tubular member comprises external threads that engage the internal threads of the first tubular member.

55. The method of claim 54, wherein radially expanding and plastically deforming the first tubular member and the second tubular member comprises:

radially expanding and plastically deforming only the portions of the first and second members proximate the threads of the first and second tubular members.

56. The method of claim 55, further comprising:

providing a fluid tight seal between the threads of the first and second tubular members.

57. The method of claim 55, further comprising:

providing a fluid tight seal between the tubular sleeve and at least one of the first and second tubular members.

58. The method of claim 1, wherein the first and second tubular members comprise wellbore casings.

59. The method of claim 1, wherein the first and second tubular members comprise pipes.

60. A method, comprising:

providing a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve;

inserting an end of a first tubular member into an end of the tubular sleeve into abutment with the internal flange;

inserting an end of a second tubular member into another end of the tubular sleeve into abutment the internal flange;

threadably coupling the ends of the first and second tubular members;

radially expanding and plastically deforming the first tubular member and the second tubular member;

placing the tubular sleeve in circumferential tension;

placing the end of the first tubular member in circumferential compression; and

placing the end of the second tubular member in circumferential compression.

61. A method, comprising:

providing a tubular sleeve comprising an external flange positioned between the ends of the

tubular sleeve;

inserting an end of the tubular sleeve into an end of a first tubular member until the end of the first tubular member abuts with the external flange;

inserting another end of the tubular sleeve into an end of the second tubular member until the end of the second tubular member abuts the external flange;

threadably coupling the ends of the first and second tubular members;

radially expanding and plastically deforming the first tubular member and the second tubular member;

placing the tubular sleeve in circumferential compression;

placing the end of the first tubular member in circumferential tension; and

placing the end of the second tubular member in circumferential tension.

62. A method, comprising:

providing a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve;

inserting an end of a first tubular member into an end of the tubular sleeve into abutment with the internal flange;

inserting an end of a second tubular member into another end of the tubular sleeve into abutment the internal flange;

threadably coupling the ends of the first and second tubular members;

radially expanding and plastically deforming only the portions of the first tubular member and the second tubular member proximate the threads of the first and second tubular members;

placing the tubular sleeve in circumferential tension;

placing the end of the first tubular member in circumferential compression; and

placing the end of the second tubular member in circumferential compression.

63. A method, comprising:

providing a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;

inserting an end of the tubular sleeve into an end of a first tubular member until the end of the first tubular member abuts with the external flange;

inserting another end of the tubular sleeve into an end of the second tubular member until the end of the second tubular member abuts the external flange;

threadably coupling the ends of the first and second tubular members;

radially expanding and plastically deforming only the portions of the first tubular member and the second tubular member proximate the threads of the first and second tubular members;

placing the tubular sleeve in circumferential compression;

placing the end of the first tubular member in circumferential tension; and

placing the end of the second tubular member in circumferential tension.

64. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve; and

a second tubular member coupled to another end of the tubular sleeve and the first tubular member.

65. The apparatus of claim 64,

wherein the tubular sleeve is in circumferential tension;

wherein the end portion of the first tubular member is in circumferential compression; and

wherein the end portion of the second tubular member is in circumferential compression.

66. The apparatus of claim 64,

wherein the tubular sleeve is in circumferential compression;

wherein the end portion of the first tubular member is in circumferential tension; and

wherein the end portion of the second tubular member is in circumferential tension.

67. The apparatus of claim 64, wherein the tubular sleeve comprises an internal flange.

68. The apparatus of claim 67, wherein the end portion of the first tubular member is received within an end of the tubular sleeve; and wherein the end portion of the second tubular member is received within another end of the tubular sleeve.

69. The apparatus of claim 68, wherein the end portions of the first and second tubular members abut the internal flange of the tubular sleeve.

70. The apparatus of claim 67, wherein the end portion of the first tubular member is received within an end of the tubular sleeve.

71. The apparatus of claim 70, wherein the end portions of the first and second tubular members abut the internal flange of the tubular sleeve.

72. The apparatus of claim 67, wherein the end portion of the second tubular member is received within an end of the tubular sleeve.

73. The apparatus of claim 72, wherein the end portions of the first and second tubular members abut the internal flange of the tubular sleeve.

74. The apparatus of claim 67, wherein the internal flange of the tubular sleeve is positioned between the ends of the tubular sleeve.

75. The apparatus of claim 67, wherein the internal flange of the tubular sleeve is positioned at an end of the tubular sleeve.

76. The apparatus of claim 64, wherein the tubular sleeve comprises an external flange.

77. The apparatus of claim 76, wherein an end portion of the tubular sleeve is received within the

first tubular member; and wherein another end portion of the tubular sleeve is received within the end portion of the second tubular member.

78. The apparatus of claim 77, wherein the end portions of the first and second tubular members abut the external flange of the tubular sleeve.

79. The apparatus of claim 76, wherein an end portion of the tubular sleeve is received within the end portion of the first tubular member.

80. The apparatus of claim 79, wherein the end portions of the first and second tubular members abut the external flange of the tubular sleeve.

81. The apparatus of claim 76, wherein an end portion of the tubular sleeve is received within the end portion of the second tubular member.

82. The apparatus of claim 81, wherein the end portions of the first and second tubular members abut the external flange of the tubular sleeve.

83. The apparatus of claim 76, wherein the external flange of the tubular sleeve is positioned between the ends of the tubular sleeve.

84. The apparatus of claim 76, wherein the external flange of the tubular sleeve is positioned at an end of the tubular sleeve.

85. The apparatus of claim 64, wherein the tubular sleeve further comprises one or more sealing members for sealing the interface between the tubular sleeve and at least one of the tubular members.

86. The apparatus of claim 64, further comprising:

a retaining ring positioned between the end of the first tubular member and the end of the tubular sleeve.

87. The apparatus of claim 86, further comprising:

another retaining ring positioned between the end of the second tubular member and the other end of the tubular sleeve.

88. The apparatus of claim 64, further comprising:

a retaining ring positioned between the end of the first tubular member and the other end of the tubular sleeve.

89. The apparatus of claim 86, wherein the retaining ring is resilient.

90. The apparatus of claim 87, wherein the retaining ring and the other retaining ring are resilient.

91. The apparatus of claim 88, wherein the retaining ring is resilient.

92. The apparatus of claim 64, wherein the end of the tubular sleeve is deformed onto the end of the first tubular member.

93. The apparatus of claim 92, wherein the other end of the tubular sleeve is deformed onto the end of the second tubular member.

94. The apparatus of claim 64, wherein the other end of the tubular sleeve is deformed onto the end of the second tubular member.

95. The apparatus of claim 64, further comprising:
a retaining ring coupled to the end of the first tubular member for retaining the tubular sleeve onto the end of the first tubular member.

96. The apparatus of claim 95, further comprising:
another retaining ring coupled to the end of the second tubular member for retaining the other end of the tubular sleeve onto the end of the second tubular member.

97. The apparatus of claim 64, further comprising:
a retaining ring coupled to the end of the second tubular member for retaining the other end of the tubular sleeve onto the end of the second tubular member.

98. The apparatus of claim 95, wherein the retaining ring is resilient.

99. The apparatus of claim 96, wherein the retaining ring and the other retaining ring are resilient.

100. The apparatus of claim 97, wherein the retaining ring is resilient.

101. The apparatus of claim 64, further comprising:
a locking ring for coupling the end of the first tubular member to the end of the tubular sleeve.

102. The apparatus of claim 101, further comprising:
another locking ring for coupling the end of the second tubular member to the other end of the tubular sleeve.

103. The apparatus of claim 64, further comprising:
a locking ring for coupling the end of the second tubular member to the other end of the tubular sleeve.

104. The apparatus of claim 64, further comprising:
a structure for receiving the first and second tubular members and the tubular sleeve;
wherein the tubular sleeve contacts the interior surface of the structure.

105. The apparatus of claim 104, wherein the tubular sleeve further comprises:
a sealing member for fluidicly sealing the interface between the tubular sleeve and the structure.

106. The apparatus of claim 104, wherein the other structure comprises a wellbore.

107. The apparatus of claim 104, wherein the other structure comprises a wellbore casing.

108. The apparatus of claim 64, wherein the tubular sleeve further comprises a sealing element coupled to the exterior surface of the tubular sleeve.

109. The apparatus of claim 64, wherein the tubular sleeve is metallic.

110. The apparatus of claim 64, wherein the tubular sleeve is non-metallic.

111. The apparatus of claim 64, wherein the tubular sleeve is plastic.

112. The apparatus of claim 64, wherein the tubular sleeve is ceramic.

113. The apparatus of claim 64, wherein the tubular sleeve is frangible.

114. The apparatus of claim 64, wherein the tubular sleeve comprises one or more longitudinal

slots.

115. The apparatus of claim 64, wherein the tubular sleeve comprises one or more radial passages.

116. The apparatus of claim 64, wherein the first and second tubular members are amorphously bonded.

117. The apparatus of claim 64, wherein the first and second tubular members are welded.

118. The apparatus of claim 64, wherein only the portions of the first and second tubular members proximate the tubular sleeve are plastically deformed.

119. The apparatus of claim 118, wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members.

120. The apparatus of claim 64, wherein the first tubular member comprises internal threads; and wherein the second tubular member comprises external threads that engage the internal threads of the first tubular member.

121. The apparatus of claim 120, wherein only the portions of the first and second members proximate the threads of the first and second tubular members are plastically deformed.

122. The apparatus of claim 121, wherein a fluid tight seal is provided between the threads of the first and second tubular members.

123. The apparatus of claim 121, wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members.

124. An apparatus, comprising:

a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve;

a first tubular member received within an end of the tubular sleeve in abutment with the internal flange that comprises internal threads; and

a second tubular member received within another end of the tubular sleeve in abutment with the internal flange that comprises external threads that engage the internal threads of the first tubular member;

wherein the tubular sleeve is in circumferential tension;

wherein the end of first tubular member is in circumferential compression; and

wherein the end of the second tubular member is in circumferential compression.

125. An apparatus, comprising:

a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;

a first tubular member that receives an end of the tubular sleeve and abuts the external flange that comprises internal threads; and

a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first

tubular member;

wherein the tubular sleeve is in circumferential compression;

wherein the first tubular member is in circumferential tension; and

wherein the second tubular member is in circumferential tension.

126. An apparatus, comprising:

a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve;

a first tubular member received within an end of the tubular sleeve in abutment with the internal flange that comprises internal threads; and

a second tubular member received within another end of the tubular sleeve in abutment with the internal flange that comprises external threads that engage the internal threads of the first tubular member;

wherein the tubular sleeve is in circumferential tension;

wherein the end of first tubular member is in circumferential compression;

wherein the end of the second tubular member is in circumferential compression;

wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members; and

wherein a fluid tight seal is provided between the threads of the first and second tubular members.

127. An apparatus, comprising:

a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;

a first tubular member that receives an end of the tubular sleeve and abuts the external flange that comprises internal threads; and

a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first tubular member;

wherein the tubular sleeve is in circumferential compression;

wherein the first tubular member is in circumferential tension;

wherein the second tubular member is in circumferential tension;

wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members; and

wherein a fluid tight seal is provided between the threads of the first and second tubular members.

128. A method of extracting geothermal energy from a subterranean source of geothermal energy, comprising:

drilling a borehole that traverses the subterranean source of geothermal energy;
positioning a first casing string within the borehole;
radially expanding and plastically deforming the first casing string within the borehole;
positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy;
overlapping a portion of the second casing string with a portion of the first casing string;
radially expanding and plastically deforming the second casing string within the borehole; and
extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings.

129. The method of claim 128, wherein the interior diameter of a passage defined by the first and second casing strings is constant.

130. The method of claim 128, wherein at least one of the first and second casing strings comprise:
a tubular sleeve;
a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and
a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member.

131. A method of extracting geothermal energy from a subterranean source of geothermal energy, comprising:
drilling a borehole that traverses the subterranean source of geothermal energy;
positioning a first casing string within the borehole;
radially expanding and plastically deforming the first casing string within the borehole;
positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy;
overlapping a portion of the second casing string with a portion of the first casing string;
radially expanding and plastically deforming the second casing string within the borehole; and
extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings;
wherein the interior diameter of a passage defined by the first and second casing strings is constant; and
wherein at least one of the first and second casing strings comprise:
a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve;
a first tubular member received within an end of the tubular sleeve in abutment with the internal flange that comprises internal threads; and

a second tubular member received within another end of the tubular sleeve in abutment with the internal flange that comprises external threads that engage the internal threads of the first tubular member.

132. A method of extracting geothermal energy from a subterranean source of geothermal energy, comprising:

drilling a borehole that traverses the subterranean source of geothermal energy;

positioning a first casing string within the borehole;

radially expanding and plastically deforming the first casing string within the borehole;

positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy;

overlapping a portion of the second casing string with a portion of the first casing string;

radially expanding and plastically deforming the second casing string within the borehole; and

extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings;

wherein the interior diameter of a passage defined by the first and second casing strings is constant; and

wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;

a first tubular member that receives an end of the tubular sleeve that abuts external flange that comprises internal threads; and

a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first tubular member.

133. A method of extracting geothermal energy from a subterranean source of geothermal energy, comprising:

drilling a borehole that traverses the subterranean source of geothermal energy;

positioning a first casing string within the borehole;

radially expanding and plastically deforming the first casing string within the borehole;

positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy;

overlapping a portion of the second casing string with a portion of the first casing string;

radially expanding and plastically deforming the second casing string within the borehole; and

extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings;

wherein the interior diameter of a passage defined by the first and second casing strings is

constant; and

wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve;

a first tubular member received within an end of the tubular sleeve in abutment with the internal flange that comprises internal threads; and

a second tubular member received within another end of the tubular sleeve in abutment with the internal flange that comprises external threads that engage the internal threads of the first tubular member;

wherein the tubular sleeve is in circumferential tension;

wherein the first tubular member is in circumferential compression;

wherein the second tubular member is in circumferential compression;

wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members; and

wherein a fluid tight seal is provided between the threads of the first and second tubular members.

134. A method of extracting geothermal energy from a subterranean source of geothermal energy, comprising:

drilling a borehole that traverses the subterranean source of geothermal energy;

positioning a first casing string within the borehole;

radially expanding and plastically deforming the first casing string within the borehole;

positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy;

overlapping a portion of the second casing string with a portion of the first casing string;

radially expanding and plastically deforming the second casing string within the borehole; and

extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings;

wherein the interior diameter of a passage defined by the first and second casing strings is constant; and

wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;

a first tubular member that receives an end of the tubular sleeve that abuts external flange that comprises internal threads; and

a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads

of the first tubular member;

wherein the tubular sleeve is in circumferential compression;

wherein the first tubular member is in circumferential tension;

wherein the second tubular member is in circumferential tension;

wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members; and

wherein a fluid tight seal is provided between the threads of the first and second tubular members.

135. An apparatus for extracting geothermal energy from a subterranean source of geothermal energy, comprising:

a borehole that traverses the subterranean source of geothermal energy;

a first casing string positioned within the borehole; and

a second casing positioned within the borehole that overlaps with the first casing string that traverses the subterranean source of geothermal energy;

wherein the first casing string and the second casing string are radially expanded and plastically deformed within the borehole.

136. The apparatus of claim 135, wherein the interior diameter of a passage defined by the first and second casing strings is constant.

137. The apparatus of claim 135, wherein at least one of the first and second casing strings comprise:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member.

138. An apparatus for extracting geothermal energy from a subterranean source of geothermal energy, comprising:

a borehole that traverses the subterranean source of geothermal energy;

a first casing string positioned within the borehole;

a second casing string within the borehole that traverses the subterranean source of geothermal energy that overlaps with the first casing string;

wherein the first and second casing strings are radially expanded and plastically deformed within the borehole;

wherein the inside diameter of a passage defined by the first and second casing strings is constant; and

wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve;

a first tubular member received within an end of the tubular sleeve in abutment with the internal flange that comprises internal threads; and

a second tubular member received within another end of the tubular sleeve in abutment with the internal flange that comprises external threads that engage the internal threads of the first tubular member.

139. An apparatus for extracting geothermal energy from a subterranean source of geothermal energy, comprising:

a borehole that traverses the subterranean source of geothermal energy;

a first casing string positioned within the borehole; and

a second casing string positioned within the borehole that traverses the subterranean source of geothermal energy that overlaps with the first casing string;

wherein the interior diameter of a passage defined by the first and second casing strings is constant; and

wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;

a first tubular member that receives an end of the tubular sleeve that abuts external flange that comprises internal threads; and

a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first tubular member.

140. An apparatus for extracting geothermal energy from a subterranean source of geothermal energy, comprising:

a borehole that traverses the subterranean source of geothermal energy;

a first casing string positioned within the borehole;

a second casing string within the borehole that traverses the subterranean source of geothermal energy that overlaps with the first casing string;

wherein the first and second casing strings are radially expanded and plastically deformed within the borehole;

wherein the inside diameter of a passage defined by the first and second casing strings is constant; and

wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an internal flange positioned between the ends of the

tubular sleeve;

a first tubular member received within an end of the tubular sleeve in abutment with the internal flange that comprises internal threads;

a second tubular member received within another end of the tubular sleeve in abutment with the internal flange that comprises external threads that engage the internal threads of the first tubular member;

wherein the tubular sleeve is in circumferential tension;

wherein the first tubular member is in circumferential compression;

wherein the second tubular member is in circumferential compression;

wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members; and

wherein a fluid tight seal is provided between the threads of the first and second tubular members.

141. An apparatus for extracting geothermal energy from a subterranean source of geothermal energy, comprising:

a borehole that traverses the subterranean source of geothermal energy;

a first casing string positioned within the borehole; and

a second casing string positioned within the borehole that traverses the subterranean source of geothermal energy that overlaps with the first casing string;

wherein the interior diameter of a passage defined by the first and second casing strings is constant; and

wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;

a first tubular member that receives an end of the tubular sleeve that abuts external flange that comprises internal threads;

a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first tubular member;

wherein the tubular sleeve is in circumferential compression;

wherein the first tubular member is in circumferential tension;

wherein the second tubular member is in circumferential tension;

wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members; and

wherein a fluid tight seal is provided between the threads of the first and second tubular members.

142. A method, comprising:

coupling the ends of first and second tubular members;

injecting a pressurized fluid through the first and second tubular members;

determining if any of the pressurized fluid leaks through the coupled ends of the first and second tubular members; and

if a predetermined amount of the pressurized fluid leaks through the coupled ends of the first and second tubular members, then coupling a tubular sleeve to the ends of the first and second tubular members and radially expanding and plastically deforming only the portions of the first and second tubular members proximate the tubular sleeve.

143. The method of claim 142, wherein radially expanding and plastically deforming only the portions of the first and second tubular members proximate the tubular sleeve comprises:

displacing an expansion cone within and relative to the first and second tubular members.

144. The method of claim 142, wherein radially expanding and plastically deforming only the portions of the first and second tubular members proximate the tubular sleeve comprises:

applying radial pressure to the interior surfaces of the first and second tubular member proximate the tubular sleeve using a rotating member.

145. The method of claim 1, further comprising:

transmitting energy through the first and second tubular members.

146. The method of claim 145, wherein the energy comprises electrical energy.

147. The method of claim 146, wherein the electrical energy comprises a communication signal.

148. The method of claim 145, wherein the energy comprises thermal energy.

149. The method of claim 145, wherein the energy comprises acoustic energy.

150. The method of claim 145, wherein the energy is transmitted through the first and second tubular members prior to radially expanding and plastically deforming the first and second tubular members.

151. The method of claim 145, wherein the energy is transmitted through the first and second tubular members after radially expanding and plastically deforming the first and second tubular members.

152. The method of claim 32, further comprising:

transmitting energy through the first and second tubular members.

153. The method of claim 152, wherein the energy comprises electrical energy.

154. The method of claim 153, wherein the electrical energy comprises a communication signal.

155. The method of claim 152, wherein the energy comprises thermal energy.

156. The method of claim 152, wherein the energy comprises acoustic energy.

157. The method of claim 152, wherein the energy is transmitted through the first and second tubular members prior to radially expanding and plastically deforming the first and second tubular

members.

158. The method of claim 152, wherein the energy is transmitted through the first and second tubular members after radially expanding and plastically deforming the first and second tubular members.

159. A system comprising:

a source of energy;

a borehole formed in the earth;

a first tubular member positioned within the borehole operably coupled to the source of energy;

a second tubular member positioned within the borehole coupled to the first tubular member; and

a tubular sleeve positioned within the borehole coupled to the first and second tubular members;

wherein the first tubular member, second tubular member, and the tubular sleeve are plastically deformed into engagement with one another.

160. The system of claim 159, wherein the source of energy comprises a source of electrical energy.

161. The system of claim 159, wherein the source of energy comprises a source of thermal energy.

162. The system of claim 159, wherein the source of energy comprises a source of acoustic energy.

163. A method of operating a well for extracting hydrocarbons from a subterranean formation, comprising:

drilling a borehole into the earth that traverses the subterranean formation;

positioning a wellbore casing in the borehole;

transmitting energy through the wellbore casing; and

extracting hydrocarbons from the subterranean formation;

wherein the wellbore casing comprises:

a first tubular member;

a second tubular member coupled to the first tubular member; and

a tubular sleeve coupled to the first and second tubular member; and

wherein the first tubular member, the second tubular member, and the tubular sleeve are plastically deformed into engagement with one another.

164. The method of claim 163, wherein the energy comprises electrical energy.

165. The system of claim 163, wherein the energy comprises thermal energy.

166. The system of claim 163, wherein the energy comprises acoustic energy.

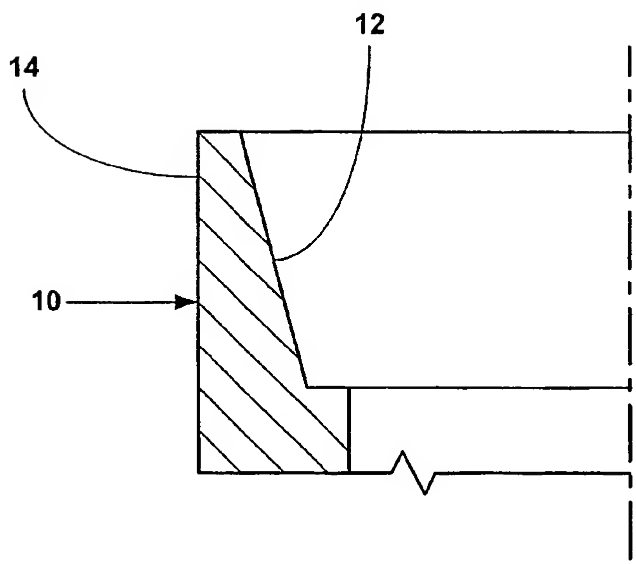

Fig. 1a

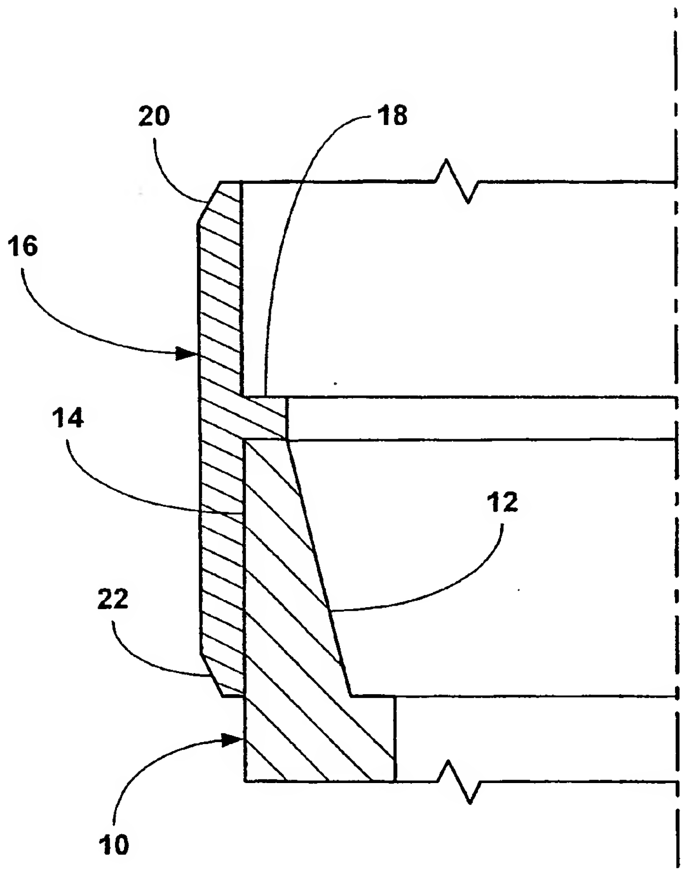

Fig. 1b

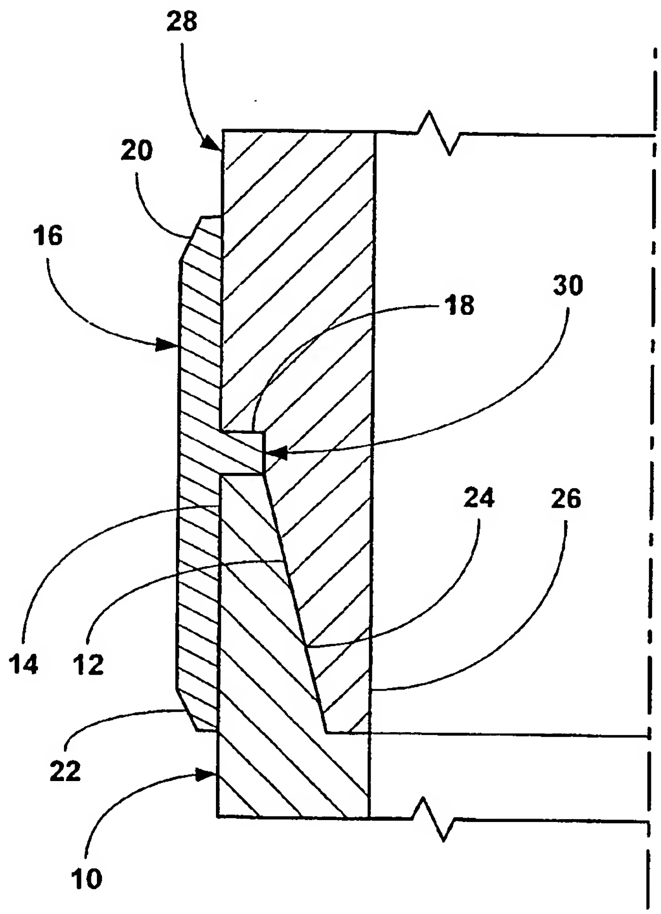

Fig. 1c

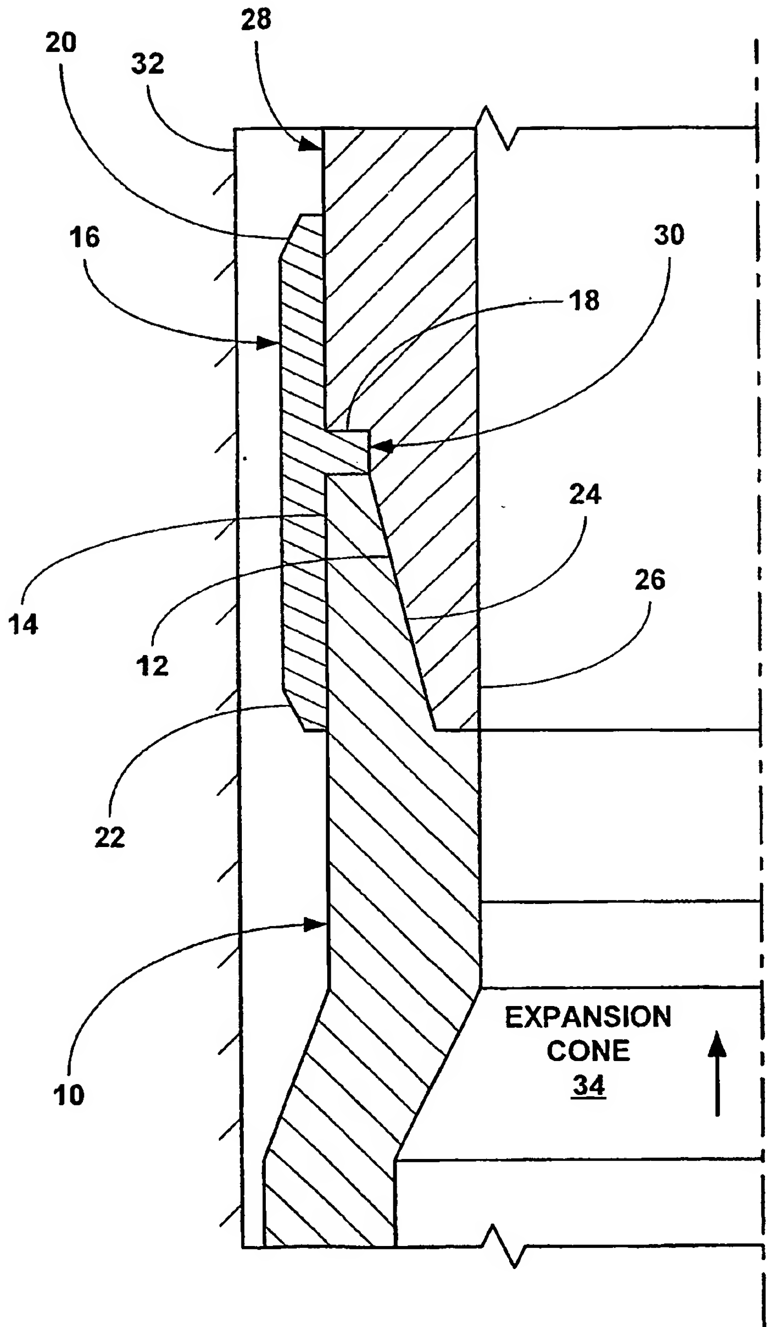

Fig. 1d

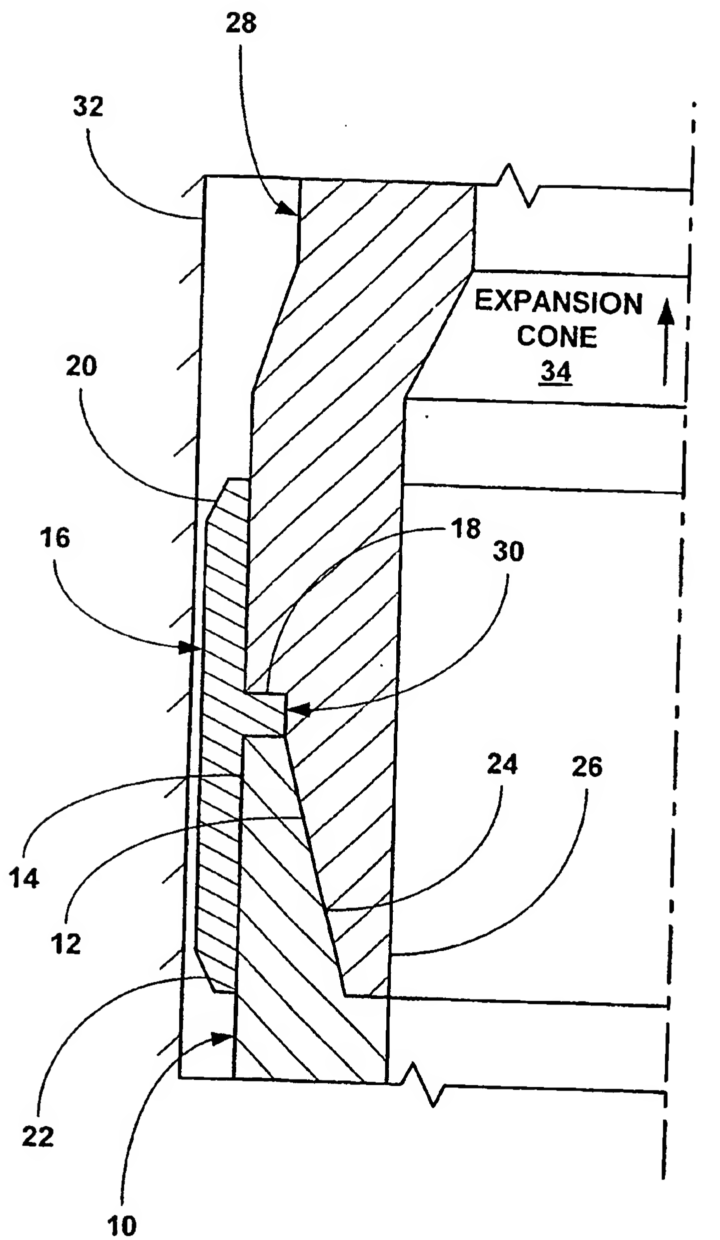

Fig. 1e

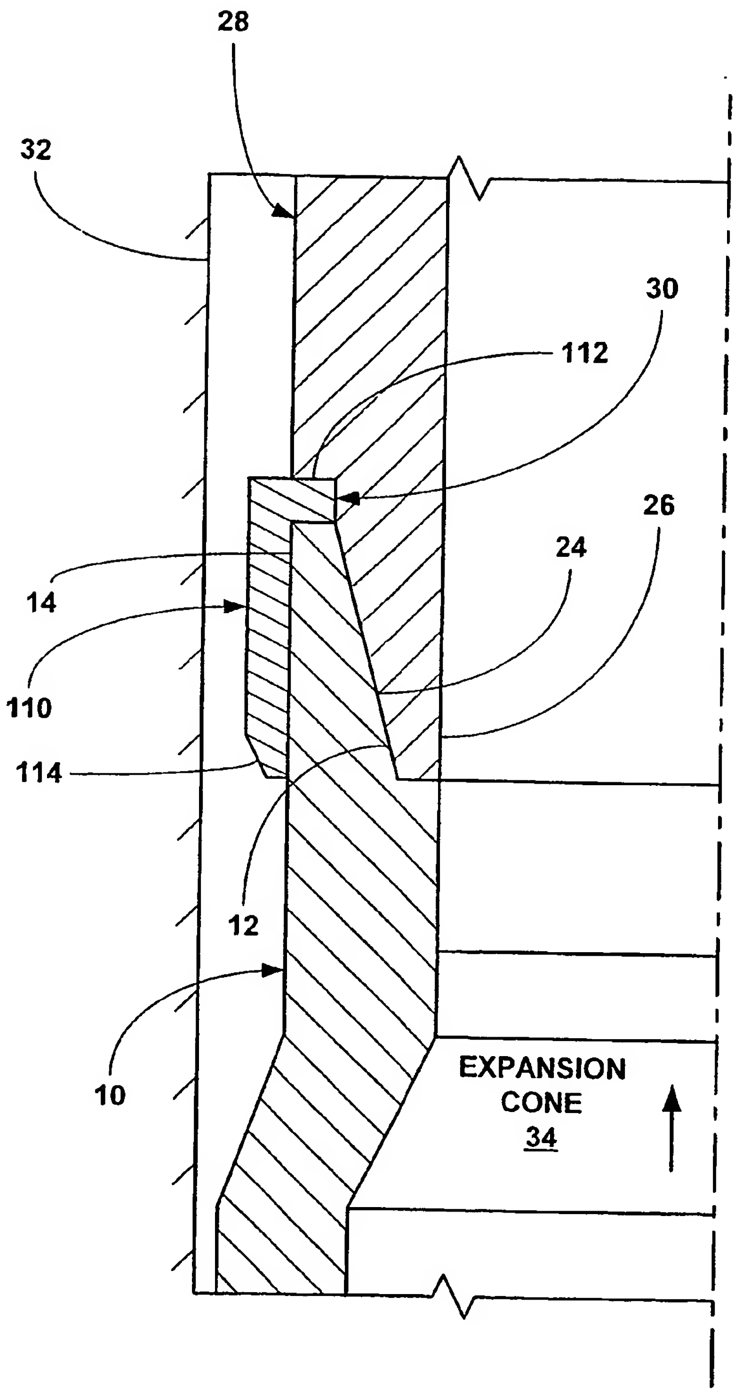

Fig. 2a

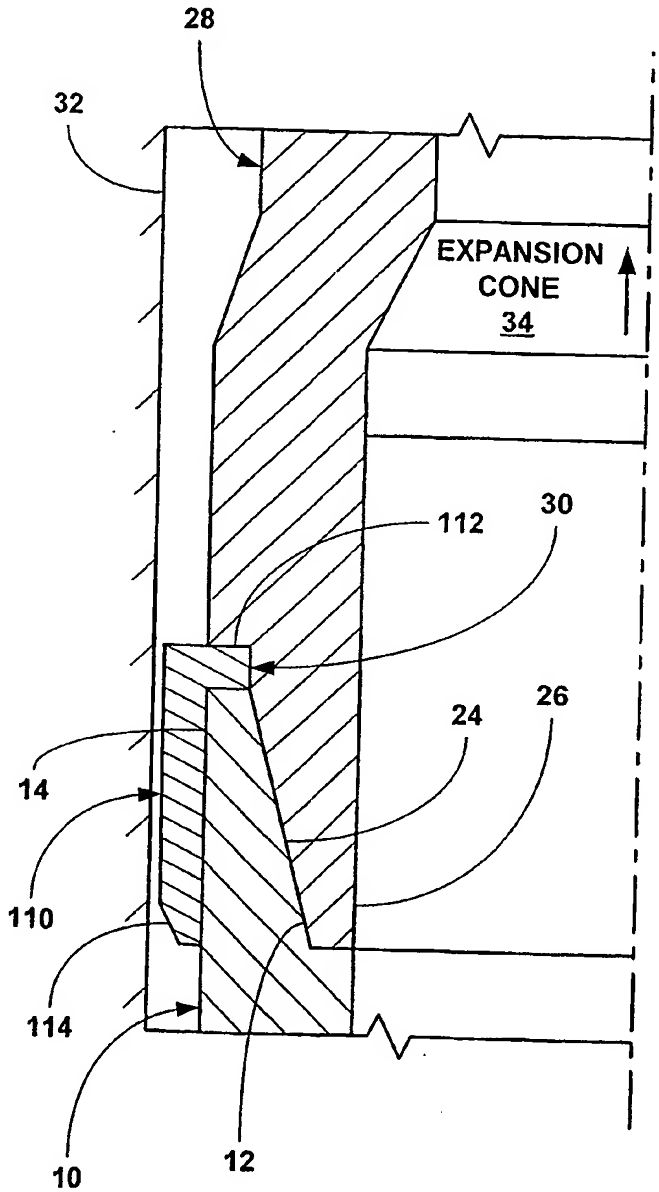

Fig. 2b

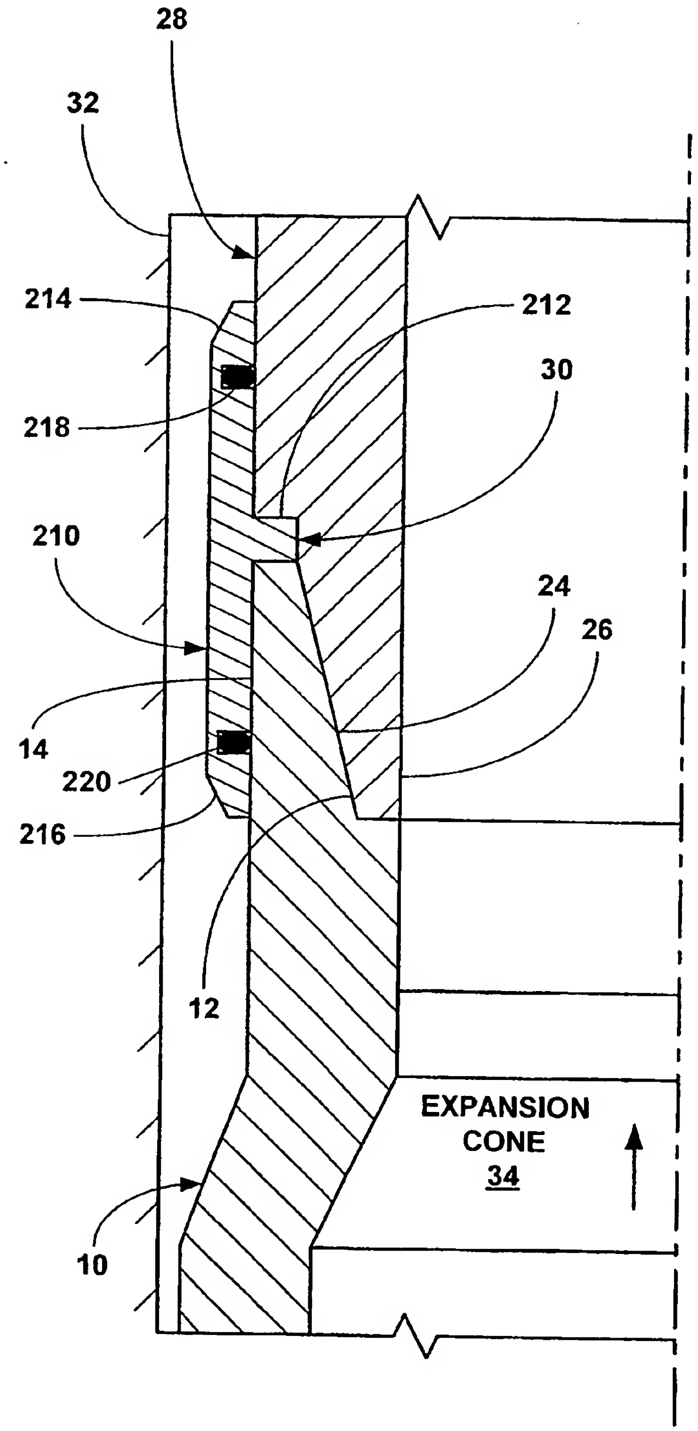

Fig. 3a

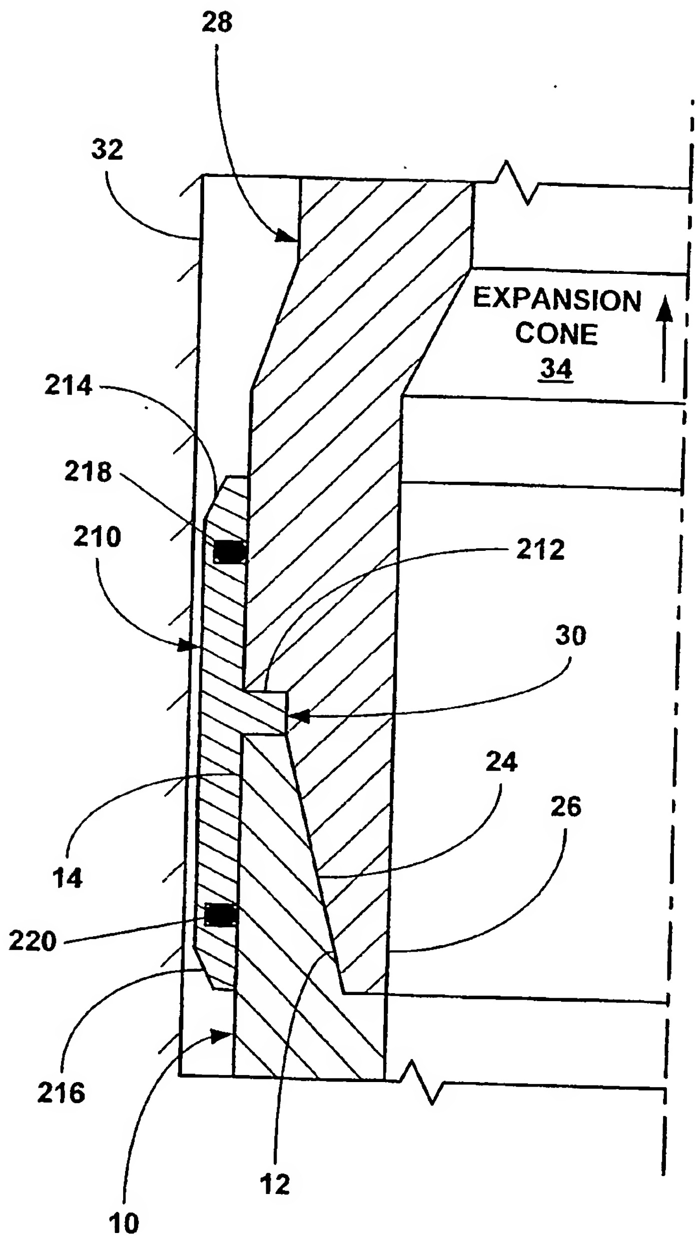

Fig. 3b

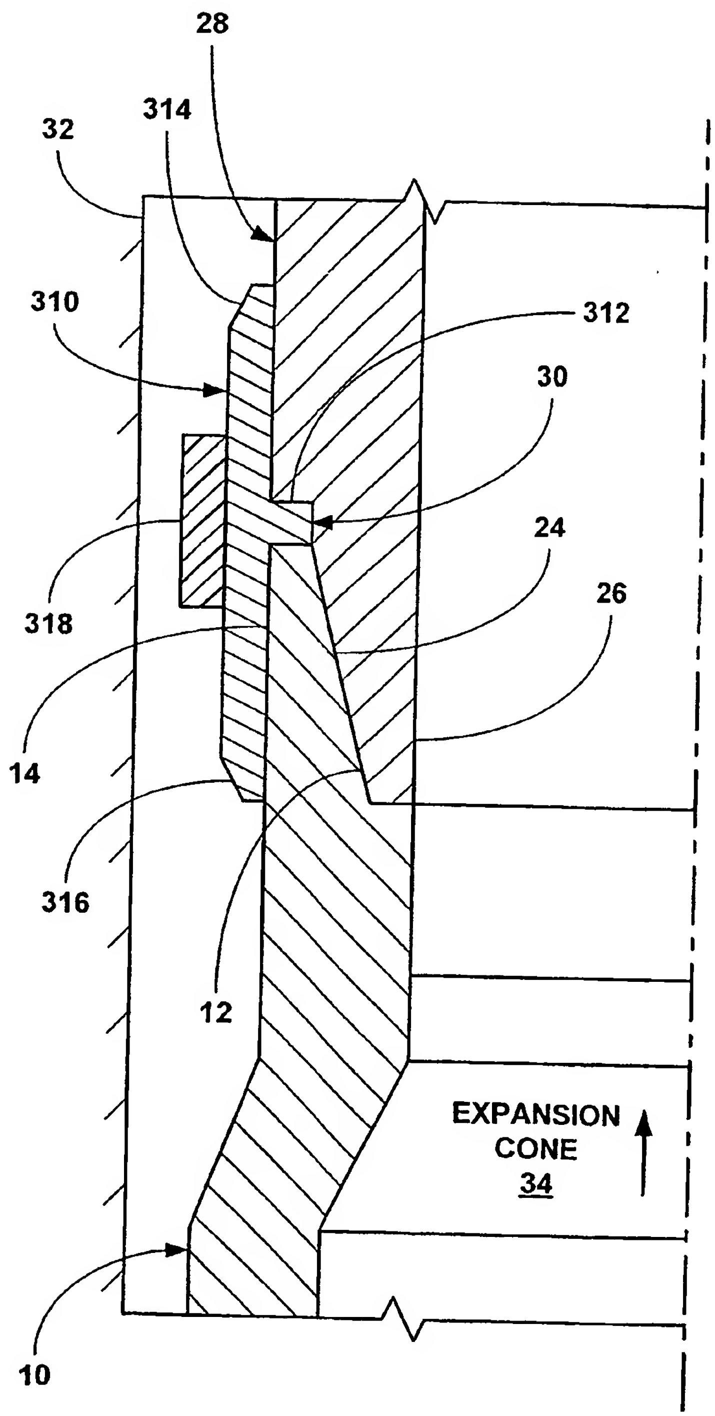

Fig. 4a

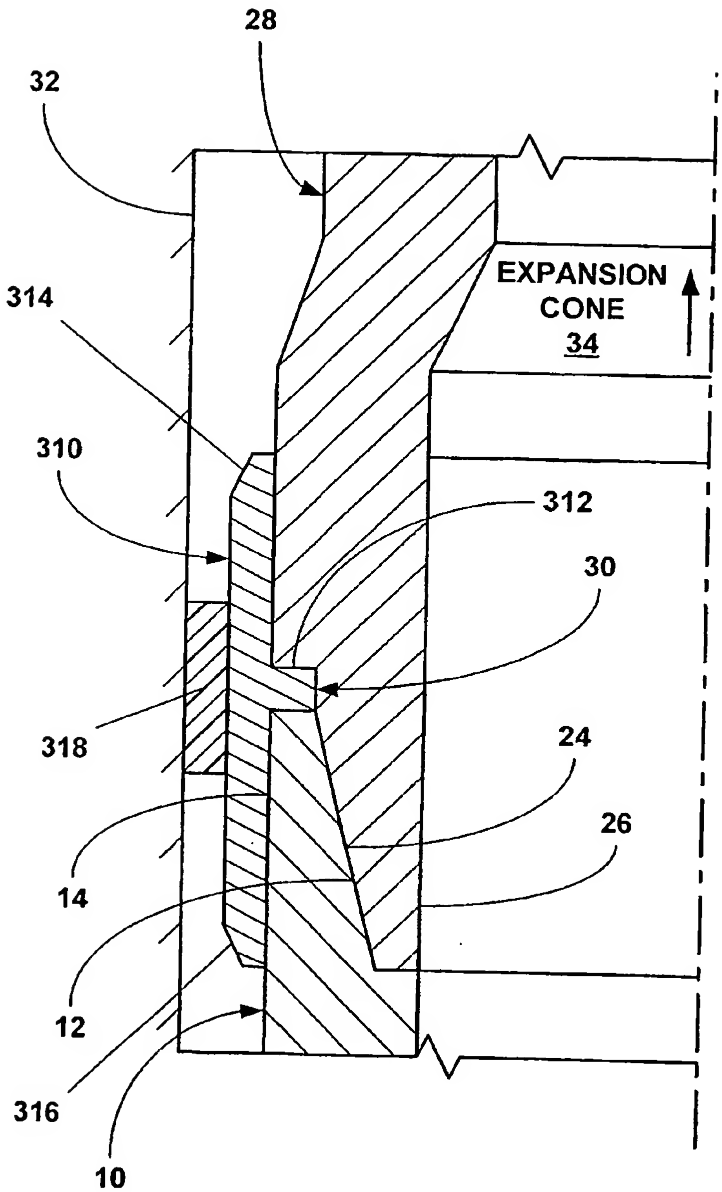

Fig. 4b

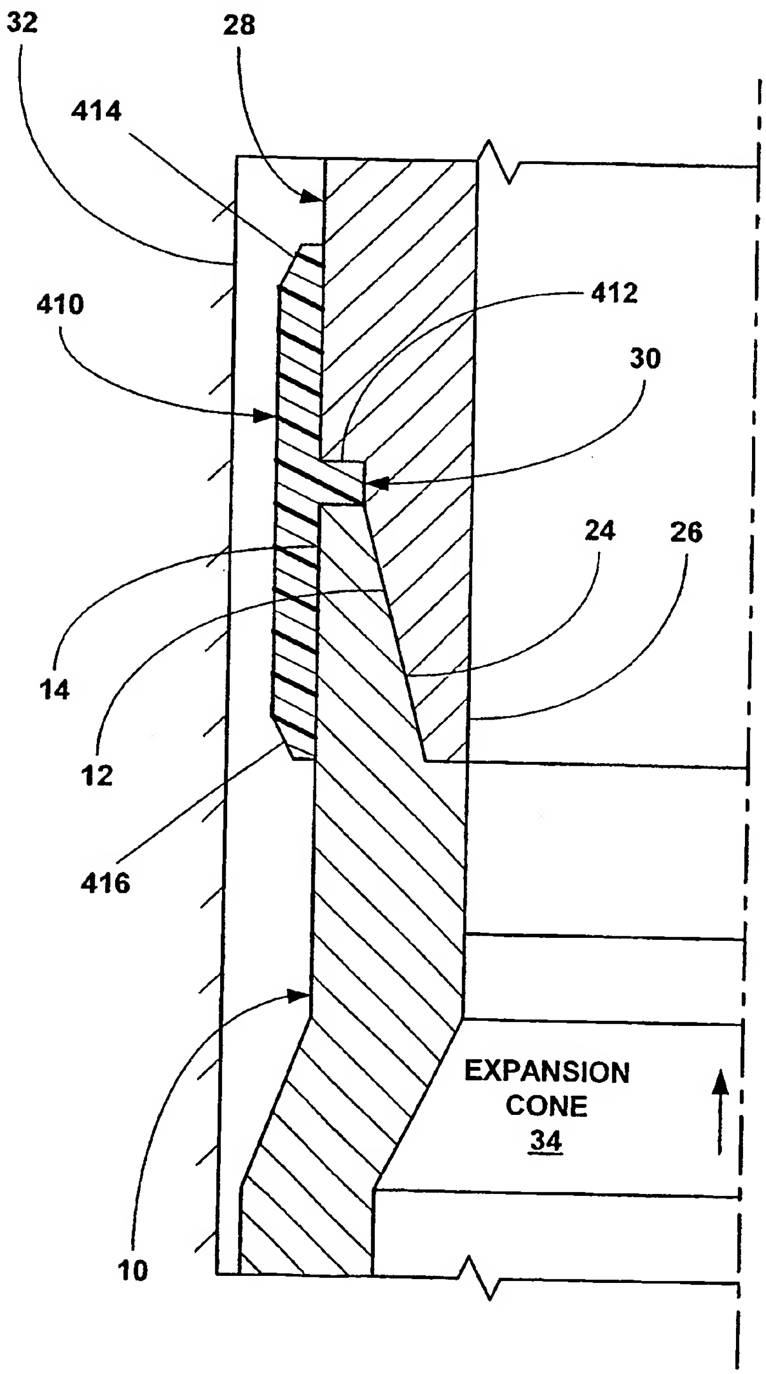

Fig. 5a

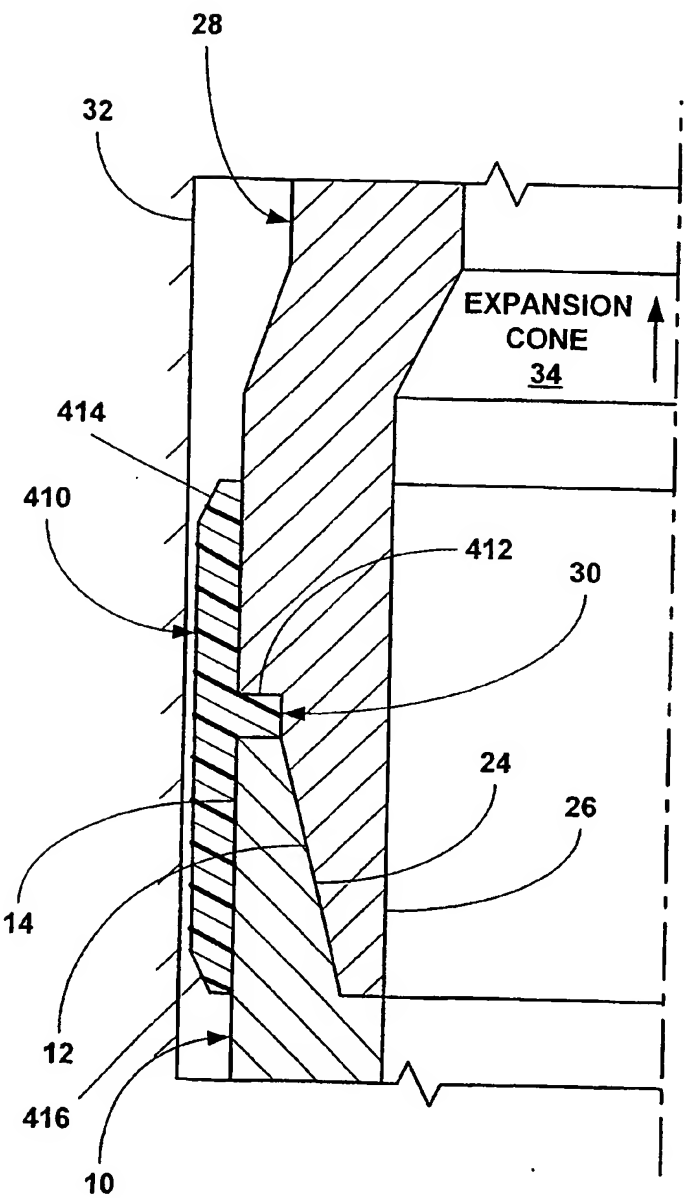

Fig. 5b

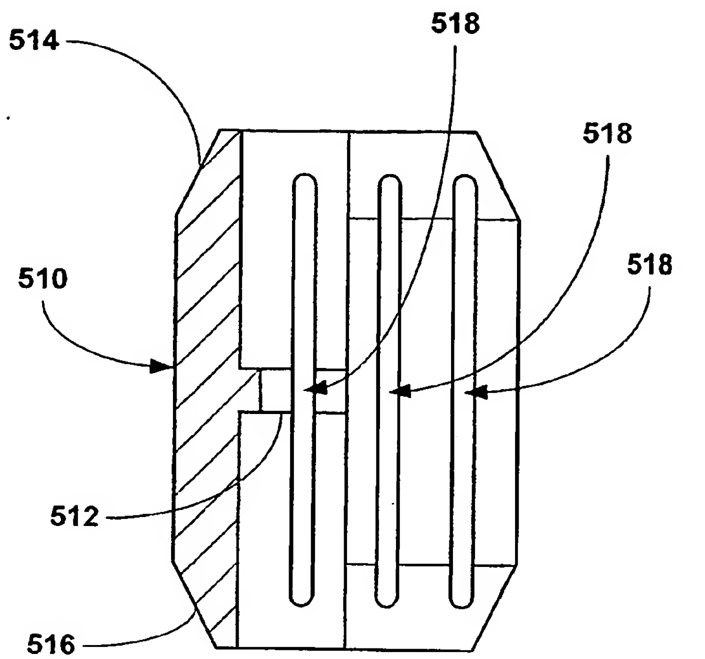

Fig. 6a

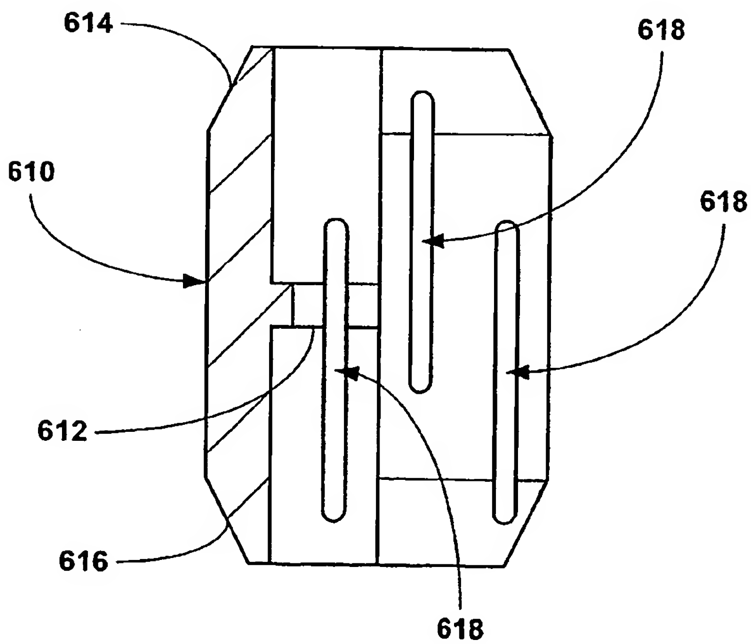

Fig. 6b

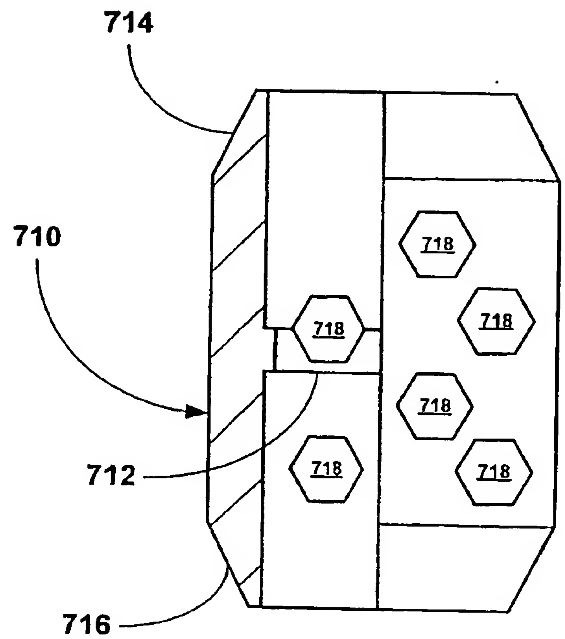
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Fig. 6c

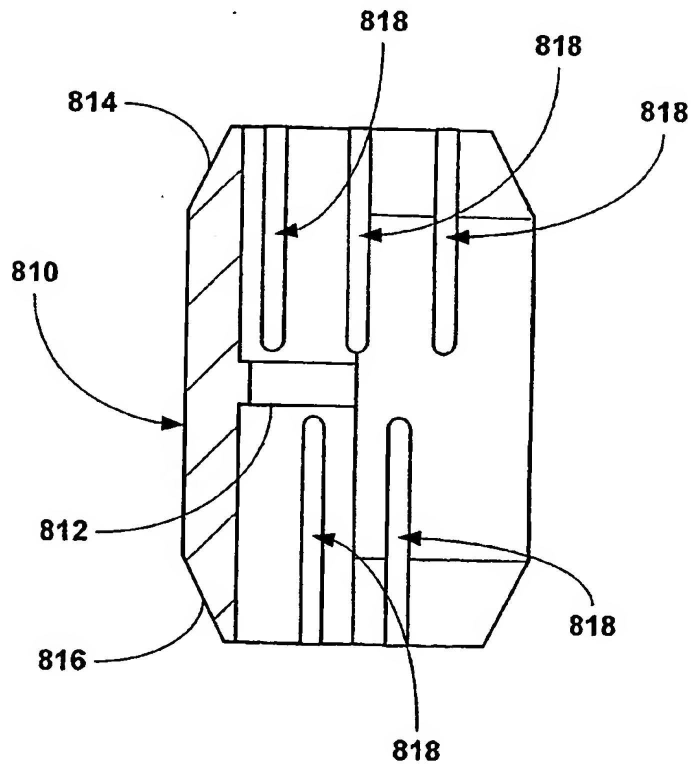
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Fig. 6d

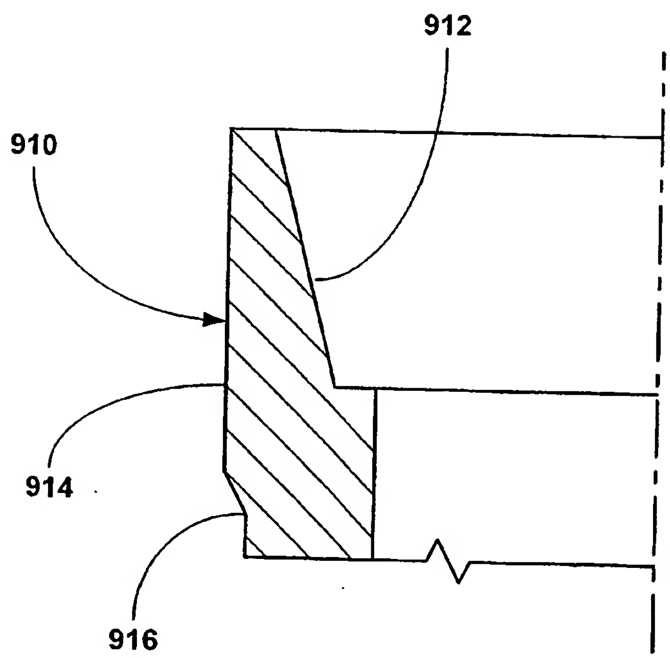

Fig. 7a

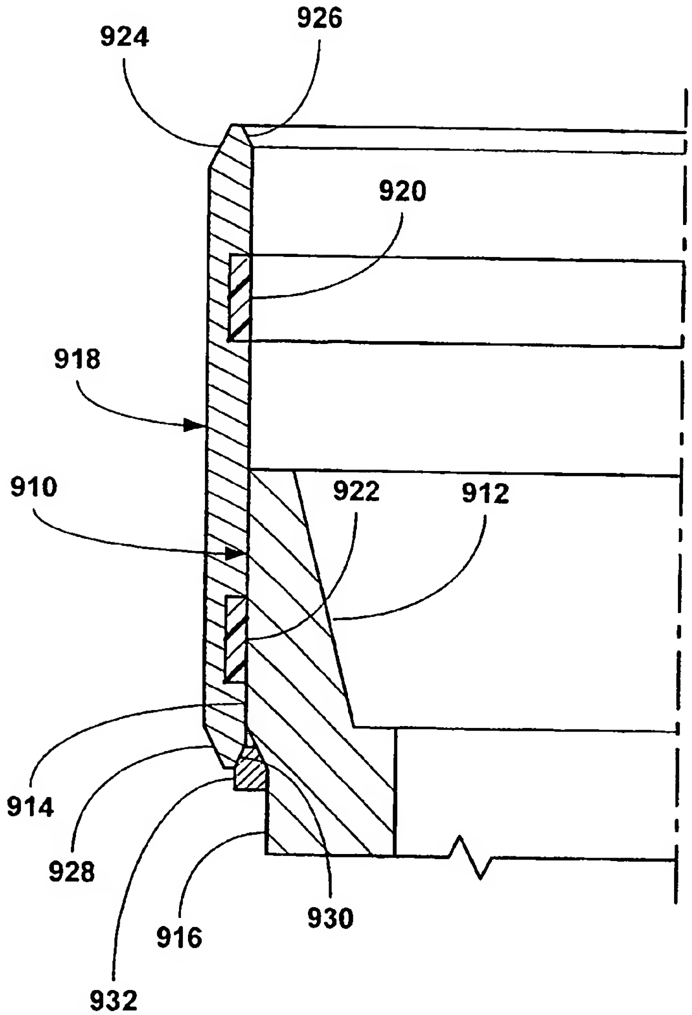

Fig. 7b

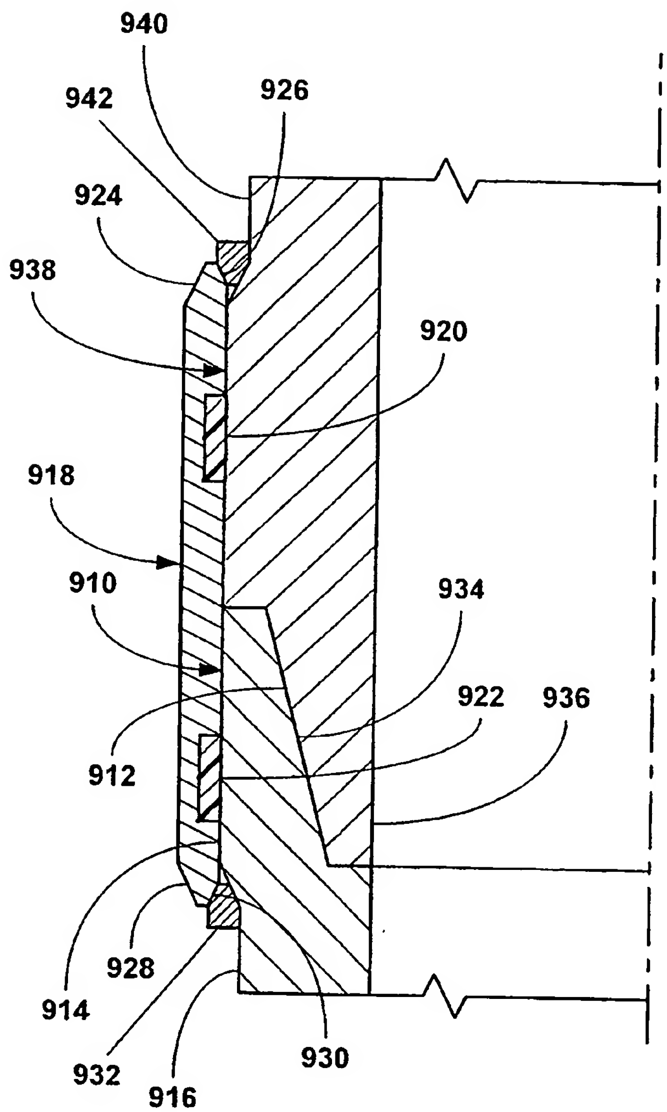
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Fig. 7c

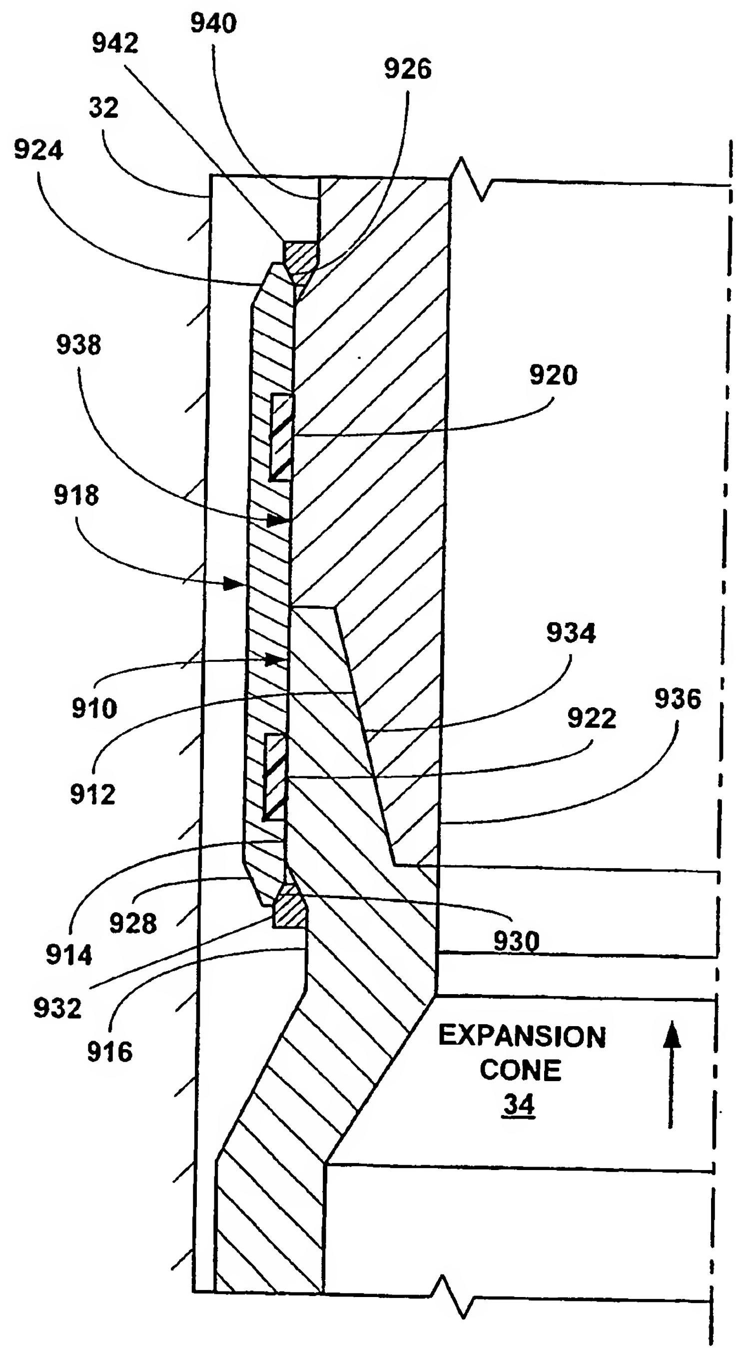
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Fig. 7d

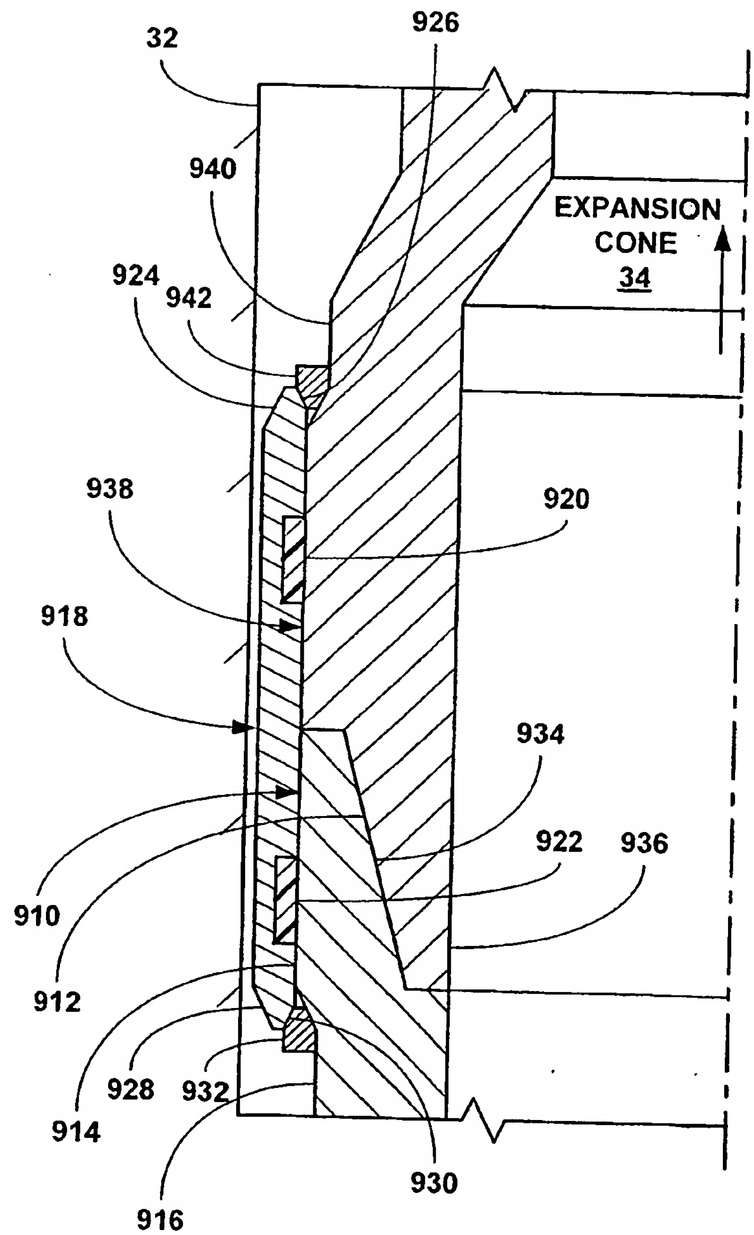
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Fig. 7e

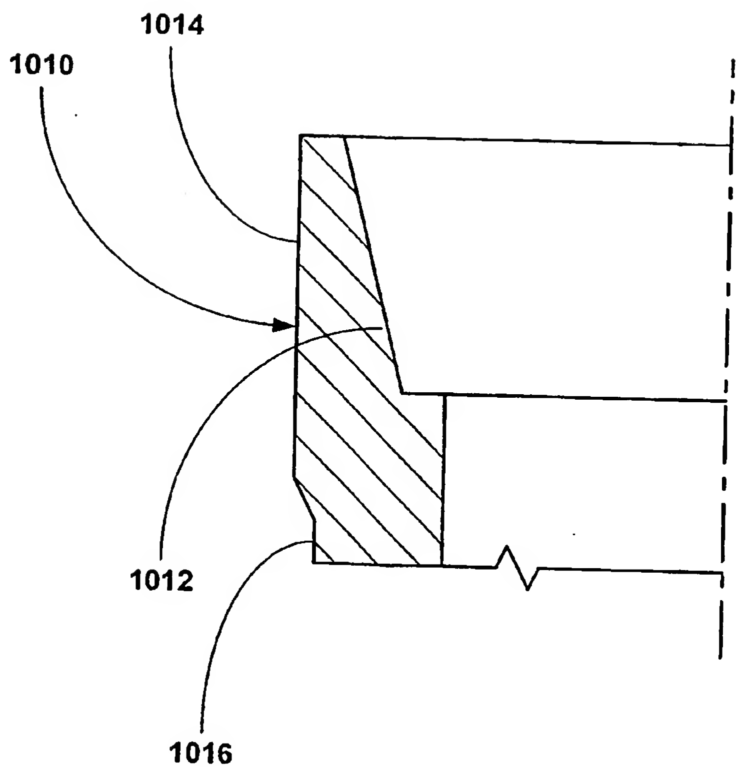


Fig. 8a

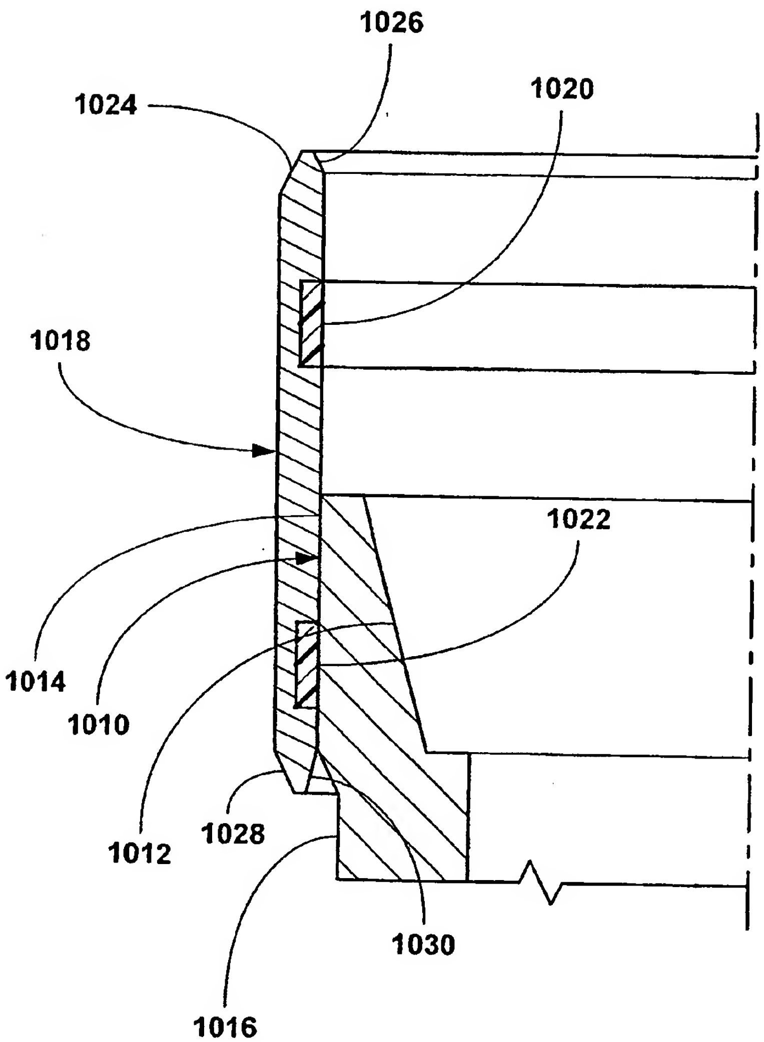
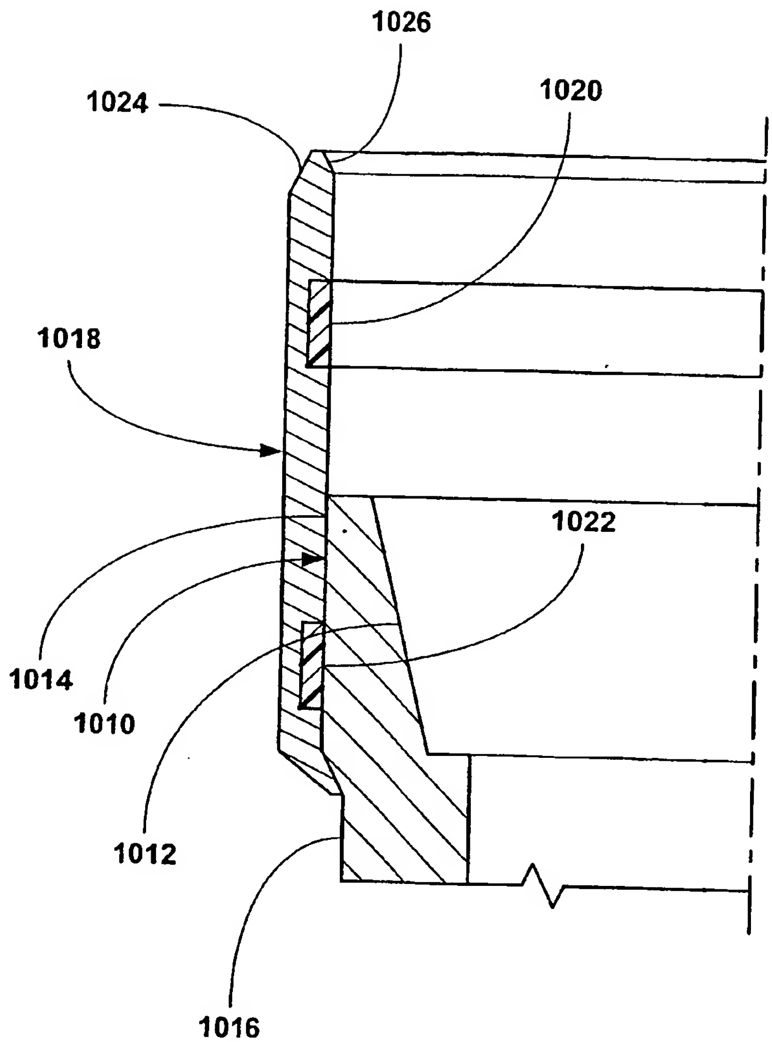


Fig. 8b



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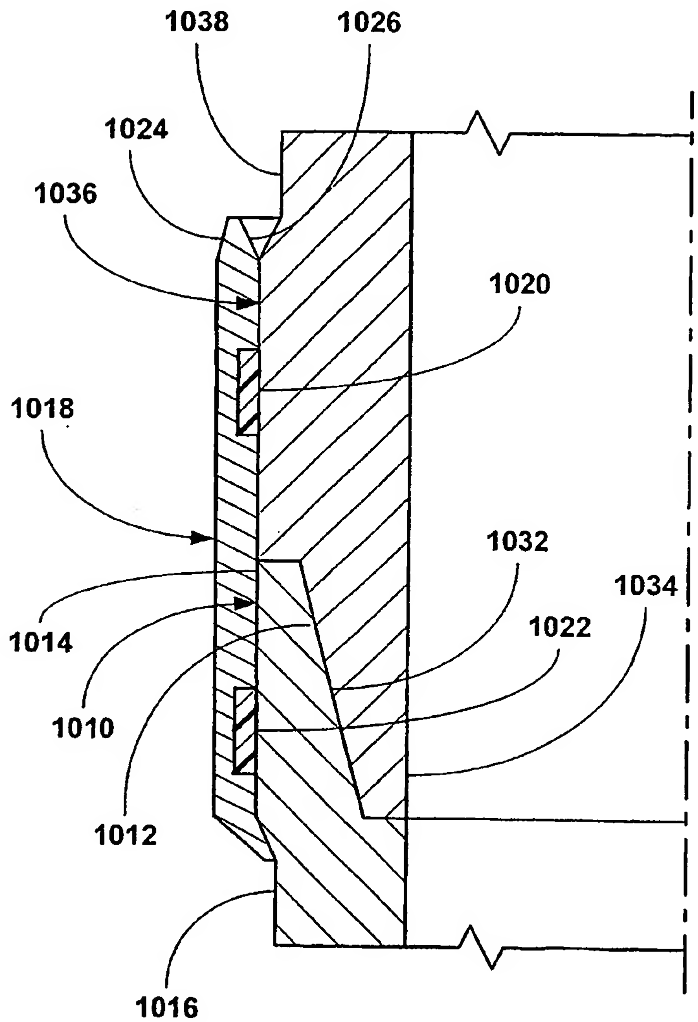
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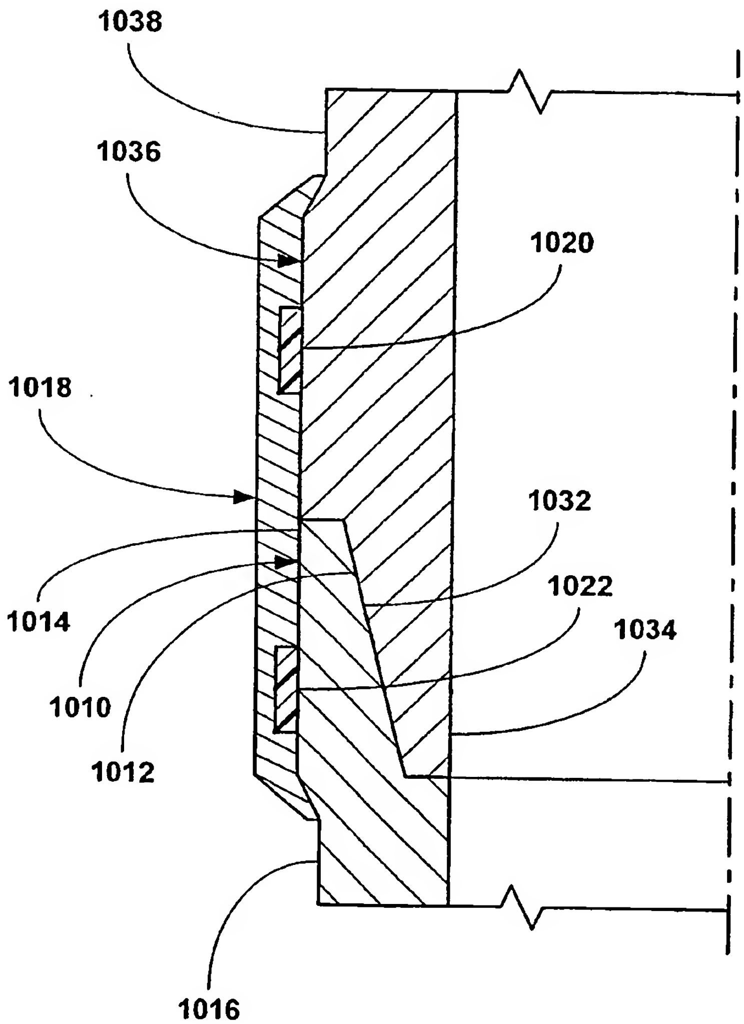
Fig. 8d



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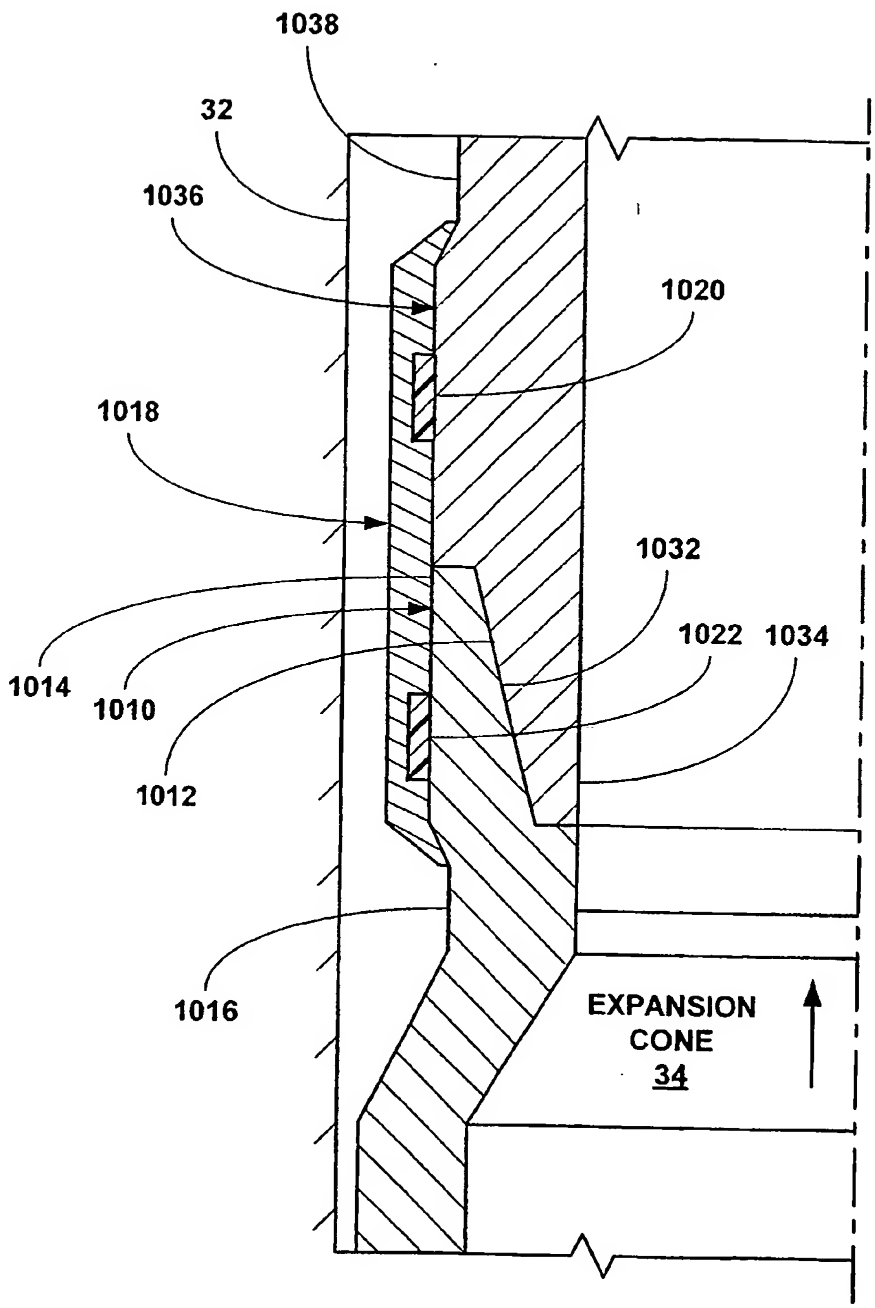
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Fig. 8f

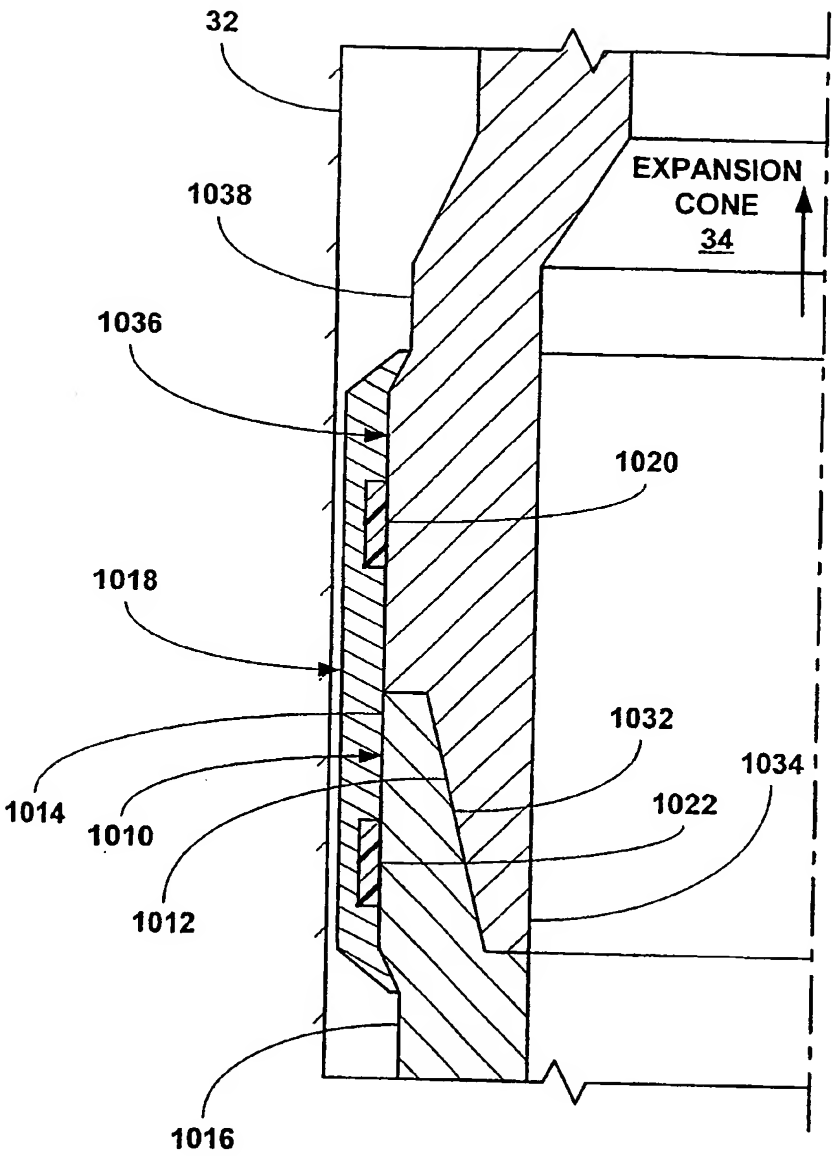
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Fig. 8g

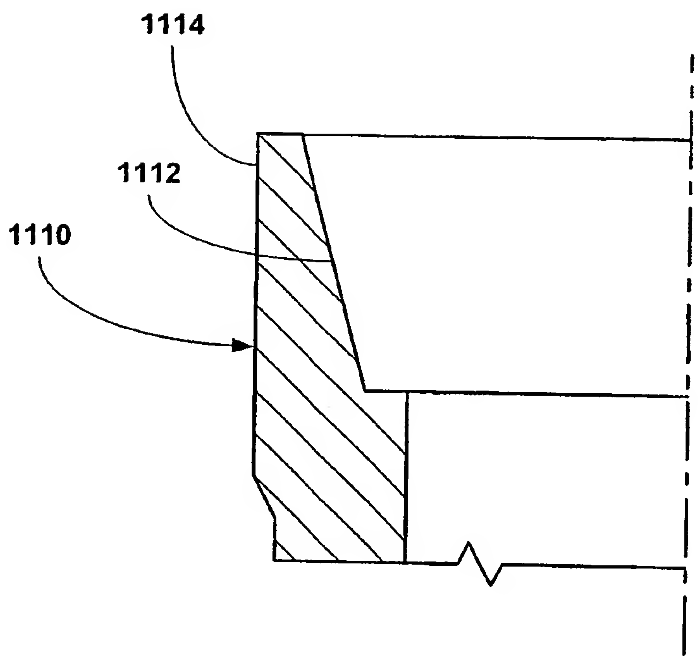

Fig. 9a

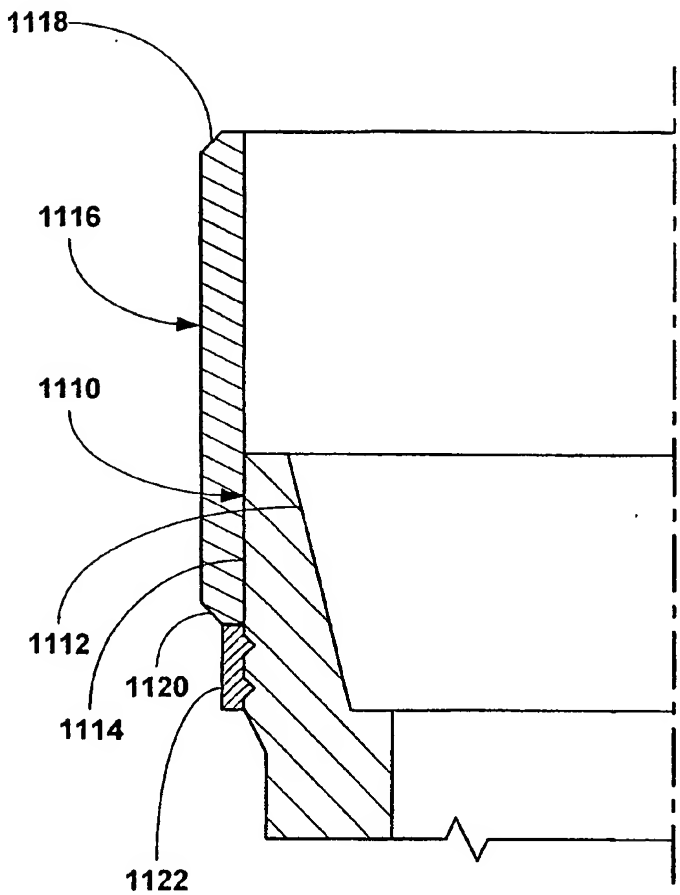

Fig. 9b

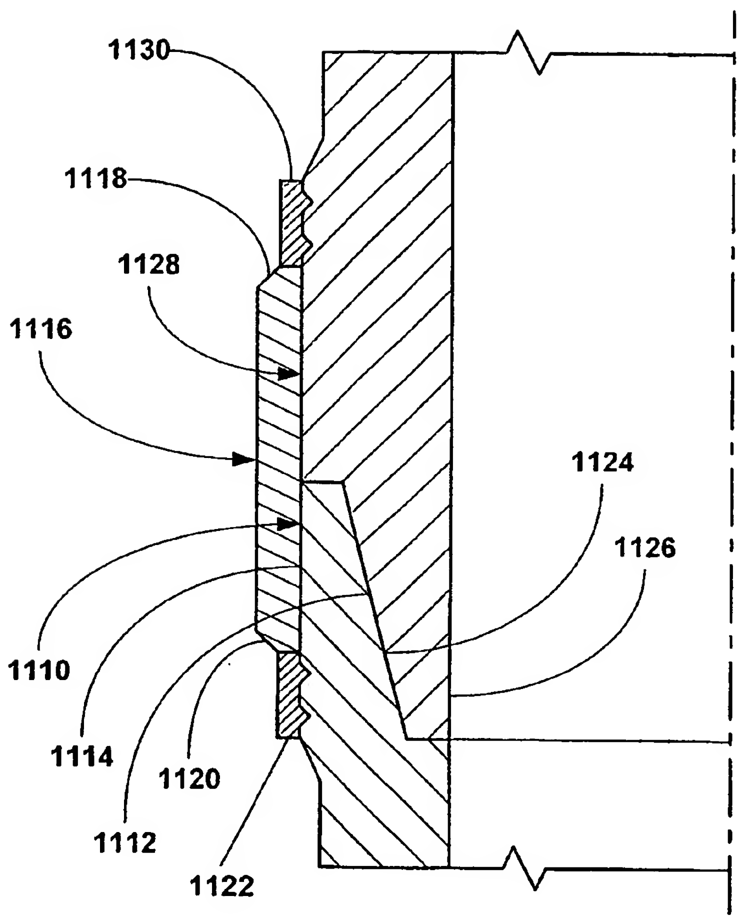

Fig. 9c

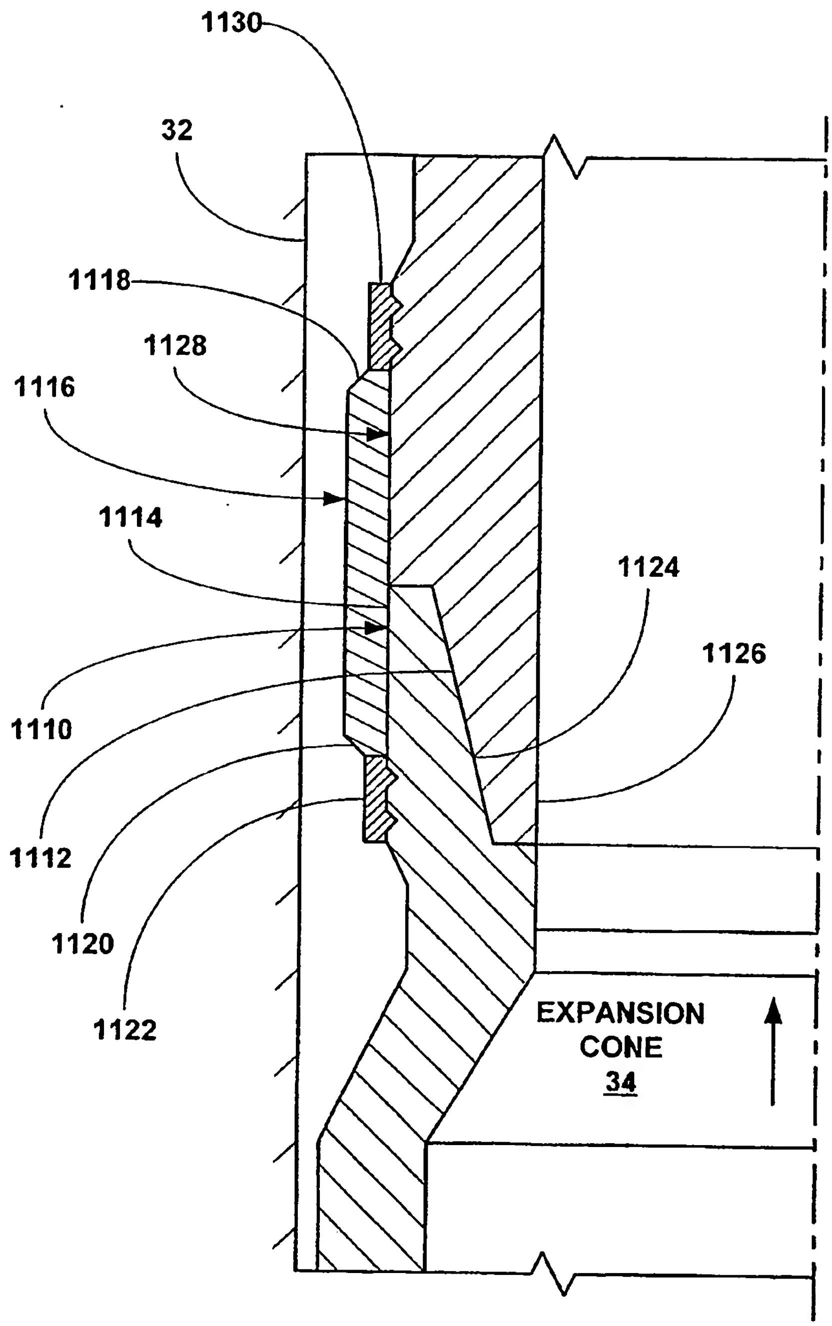
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Fig. 9d

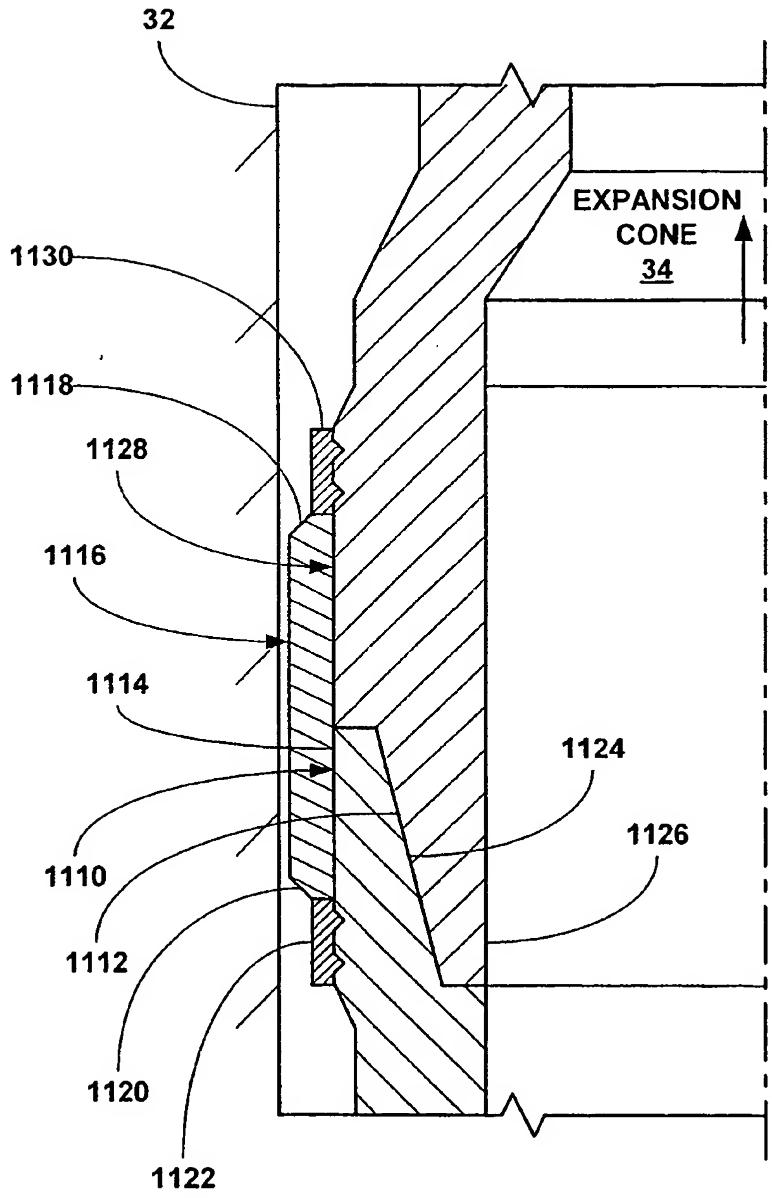
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Fig. 9e

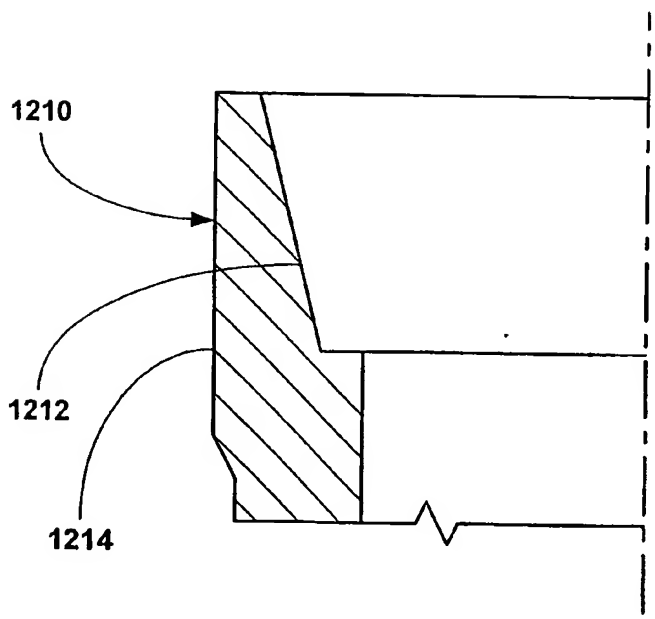

Fig. 10a

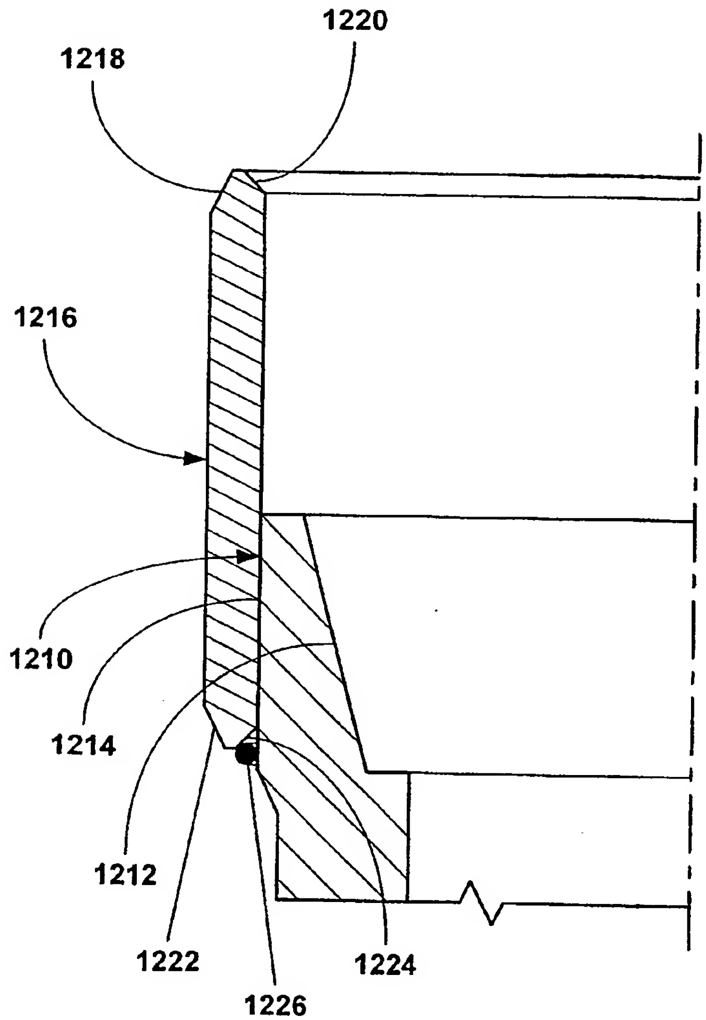

Fig. 10b

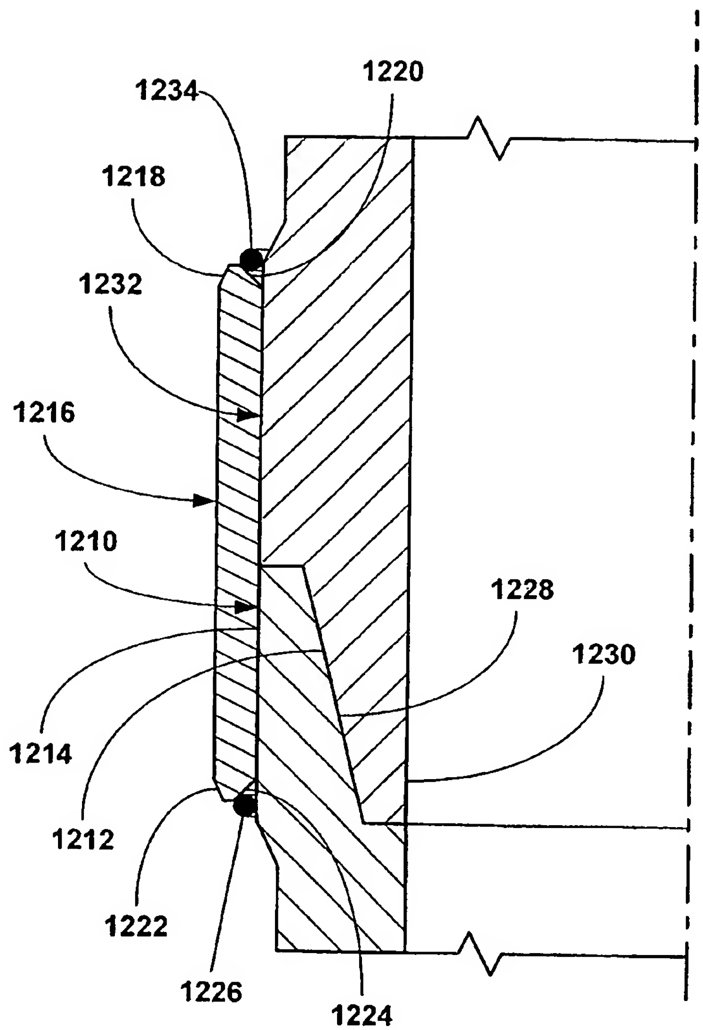
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Fig. 10c

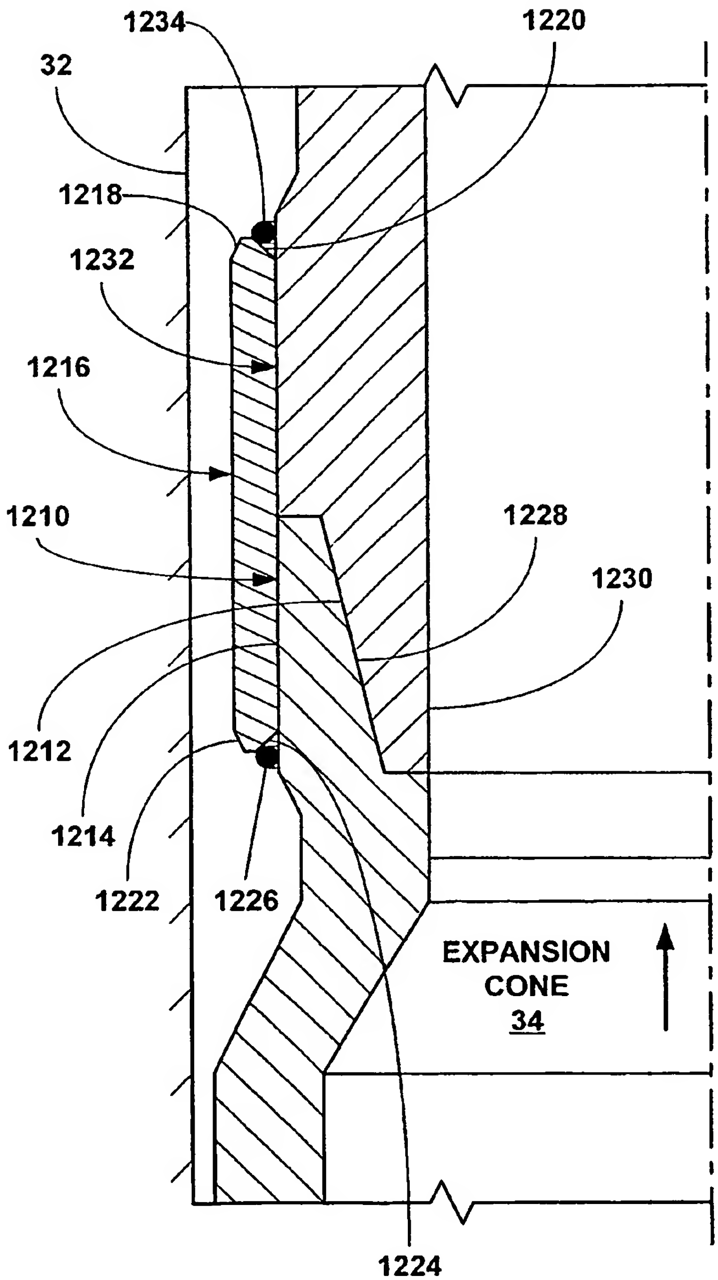
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Fig. 10d

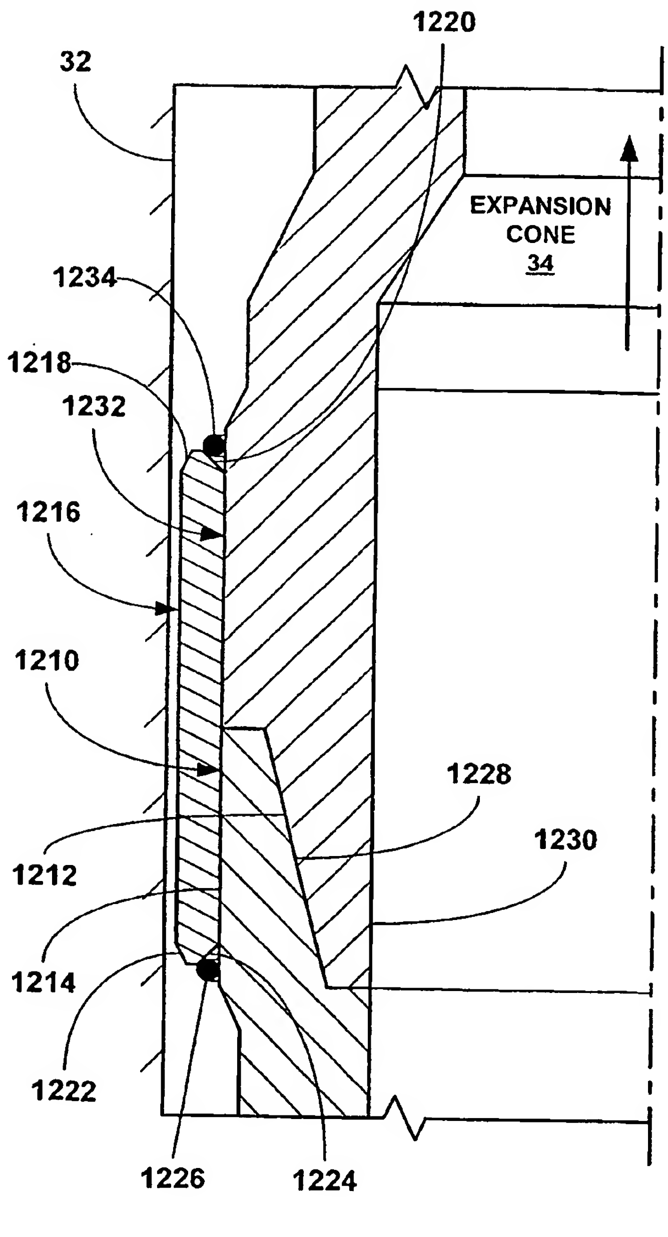
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Fig. 10e

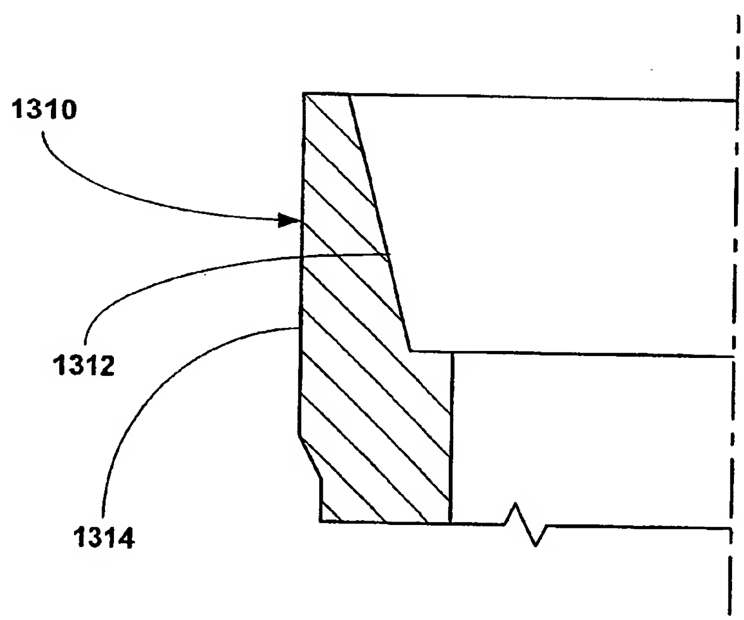

Fig. 11a

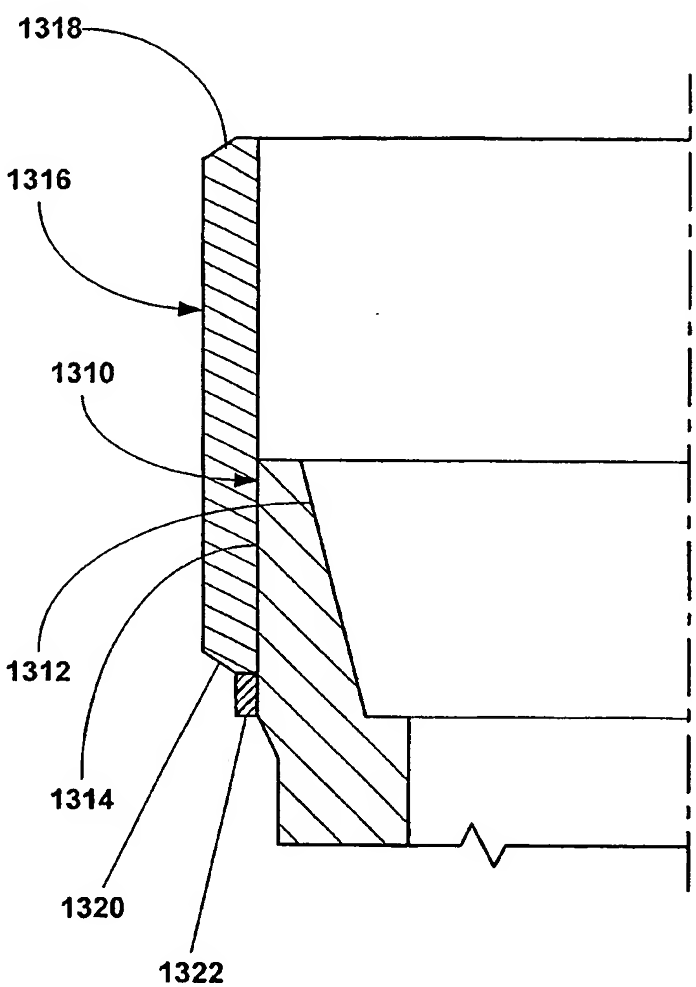

Fig. 11b

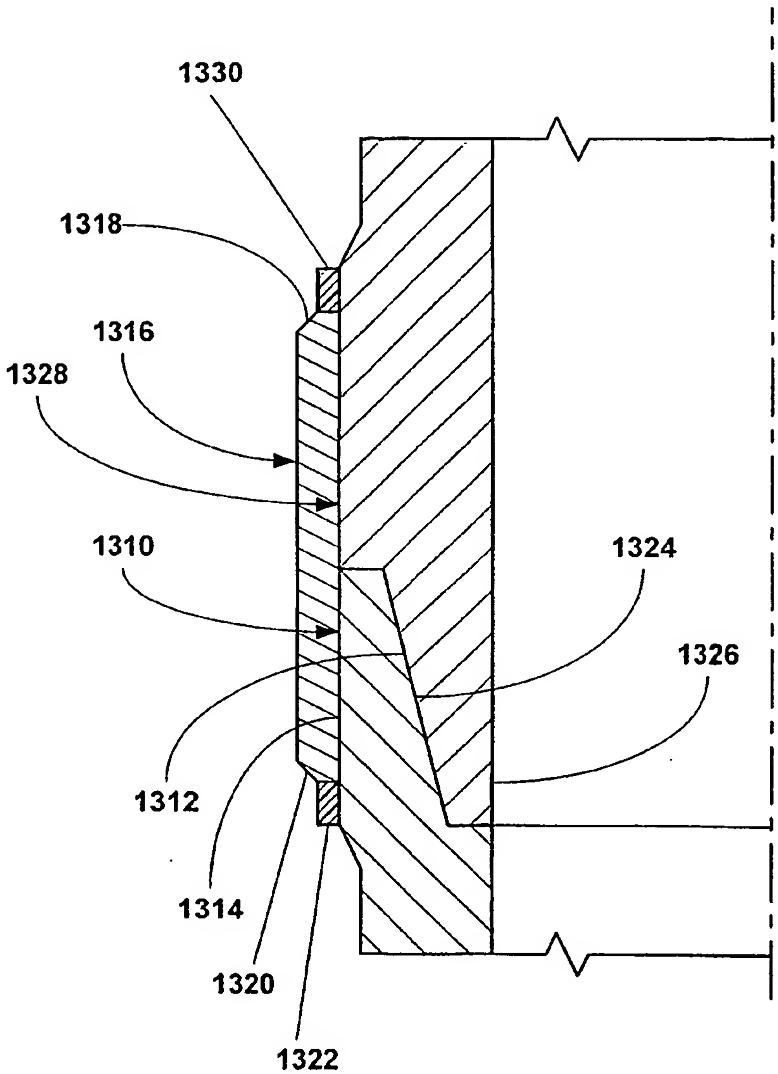

Fig. 11c

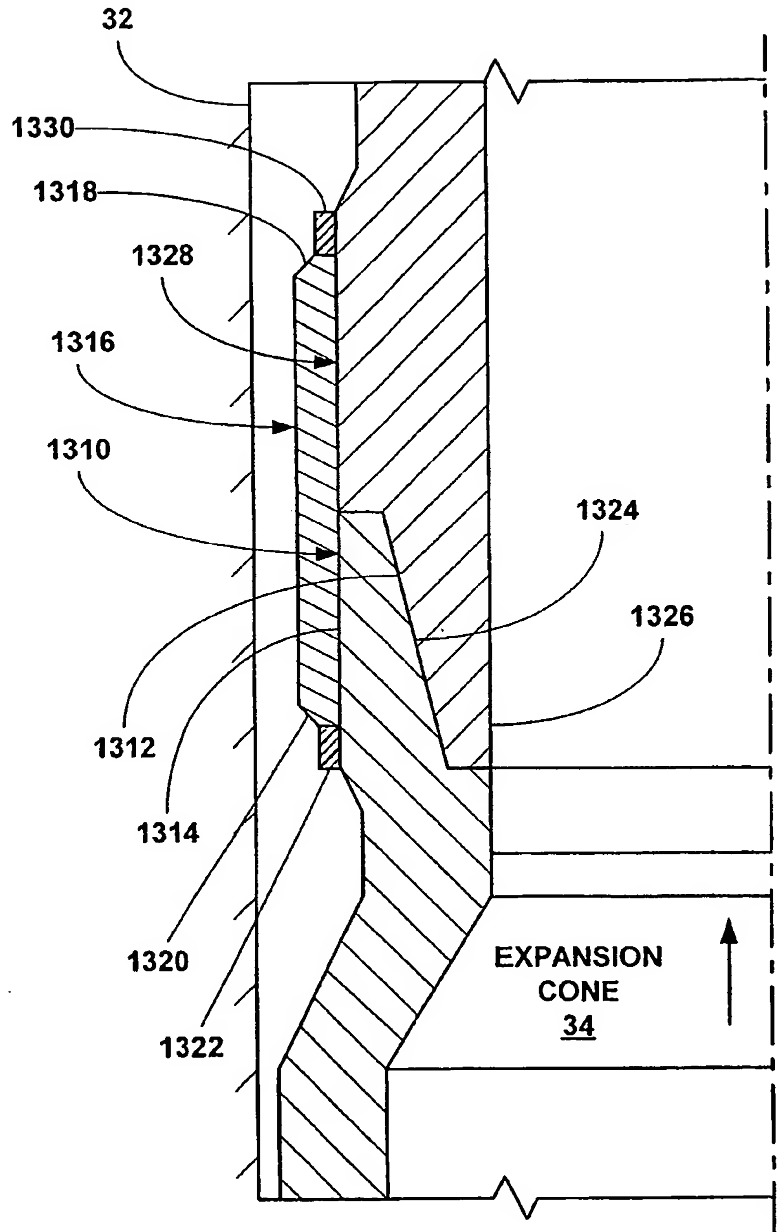
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Fig. 11d

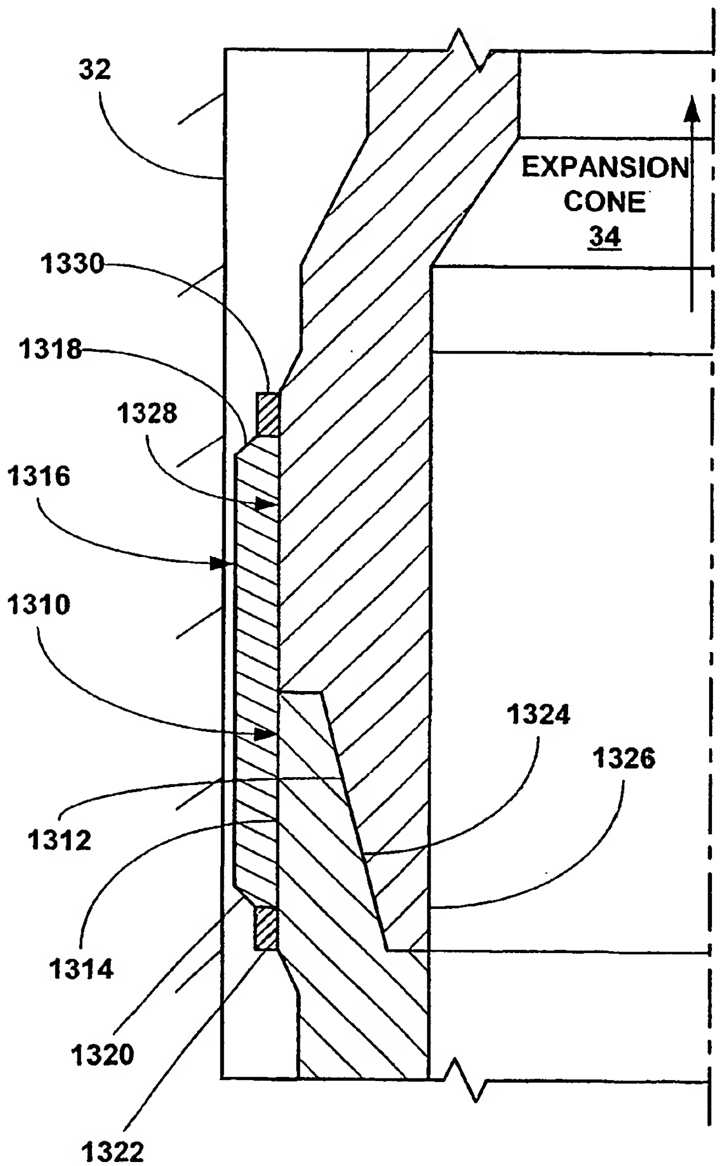
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Fig. 11e

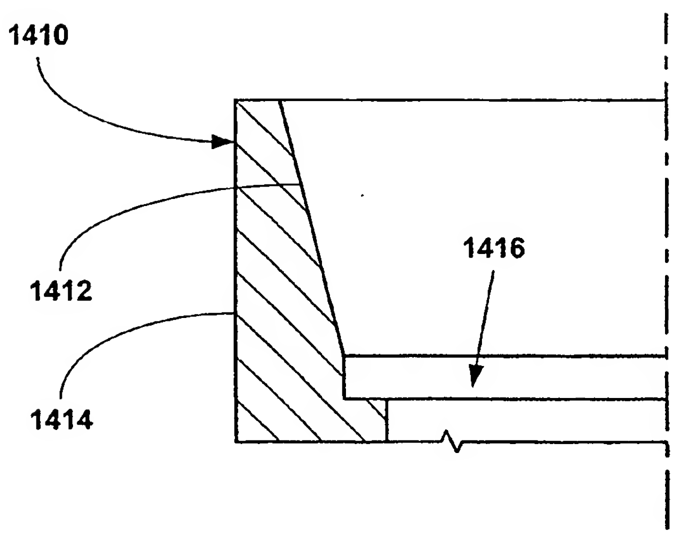

Fig. 12a

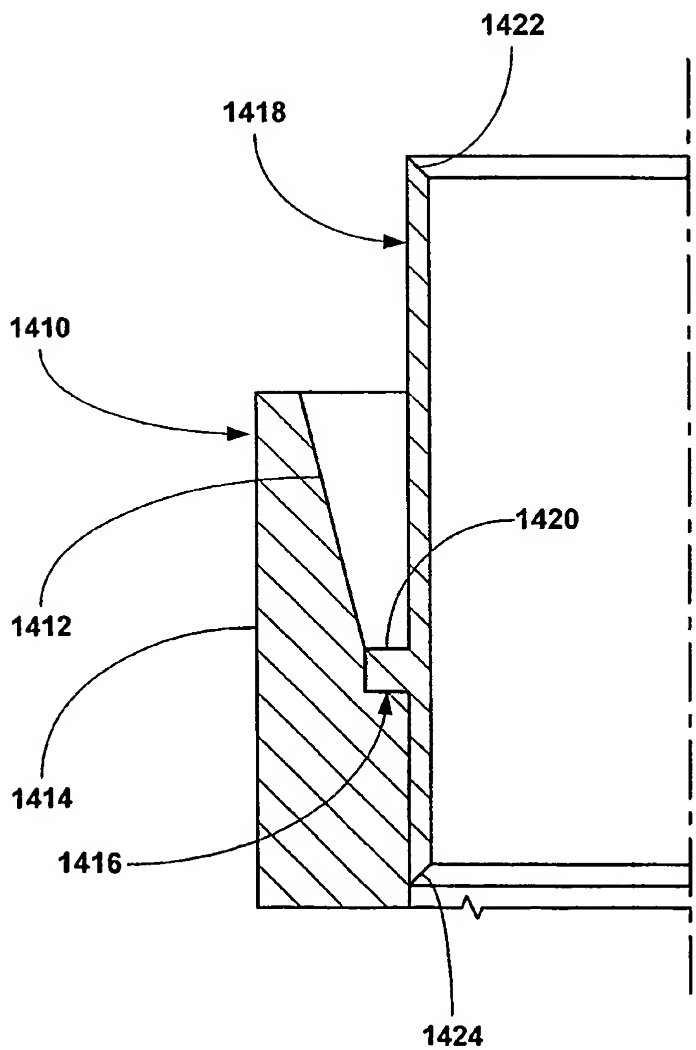

Fig. 12b

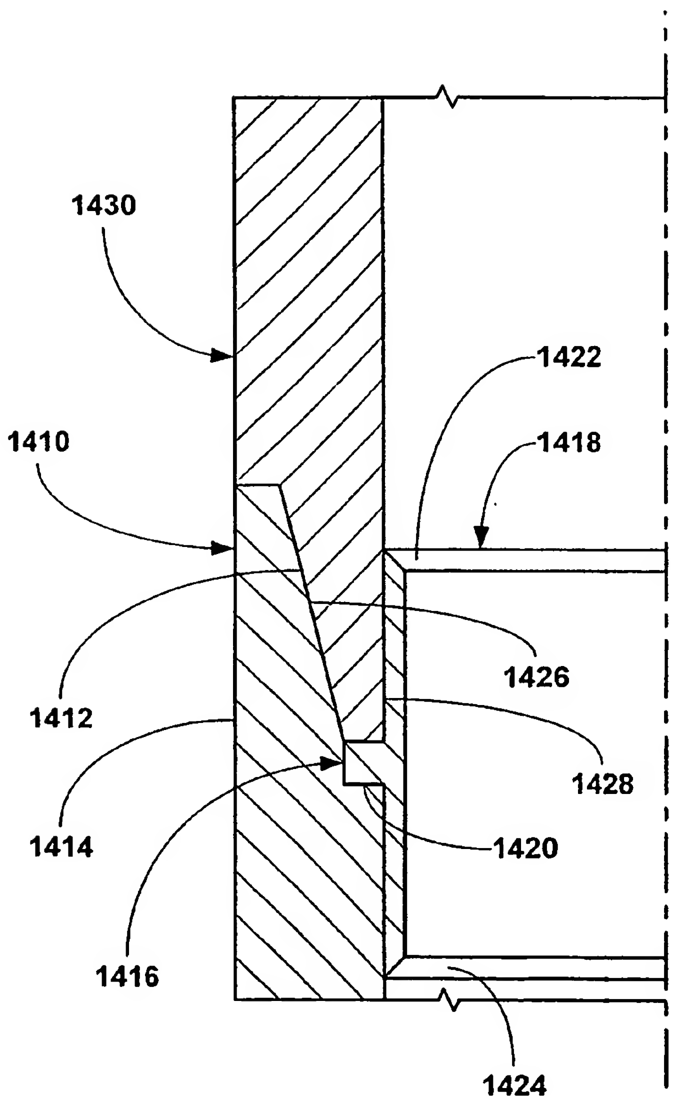

Fig. 12c

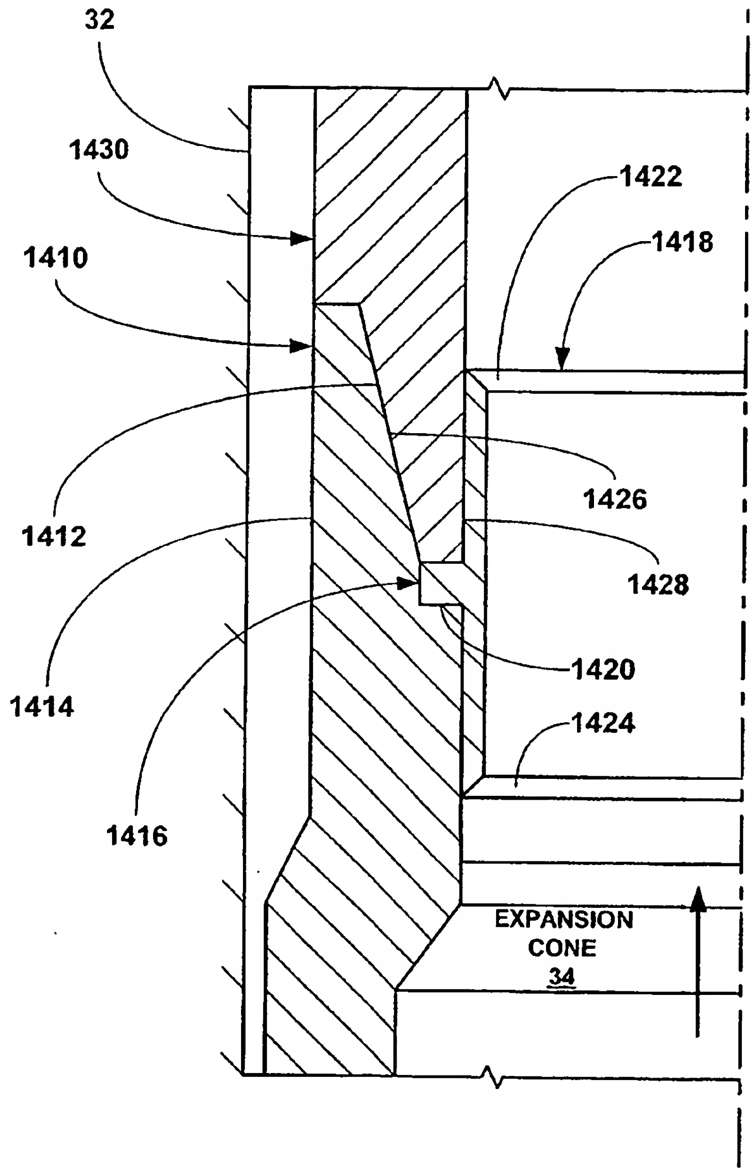
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Fig. 12d

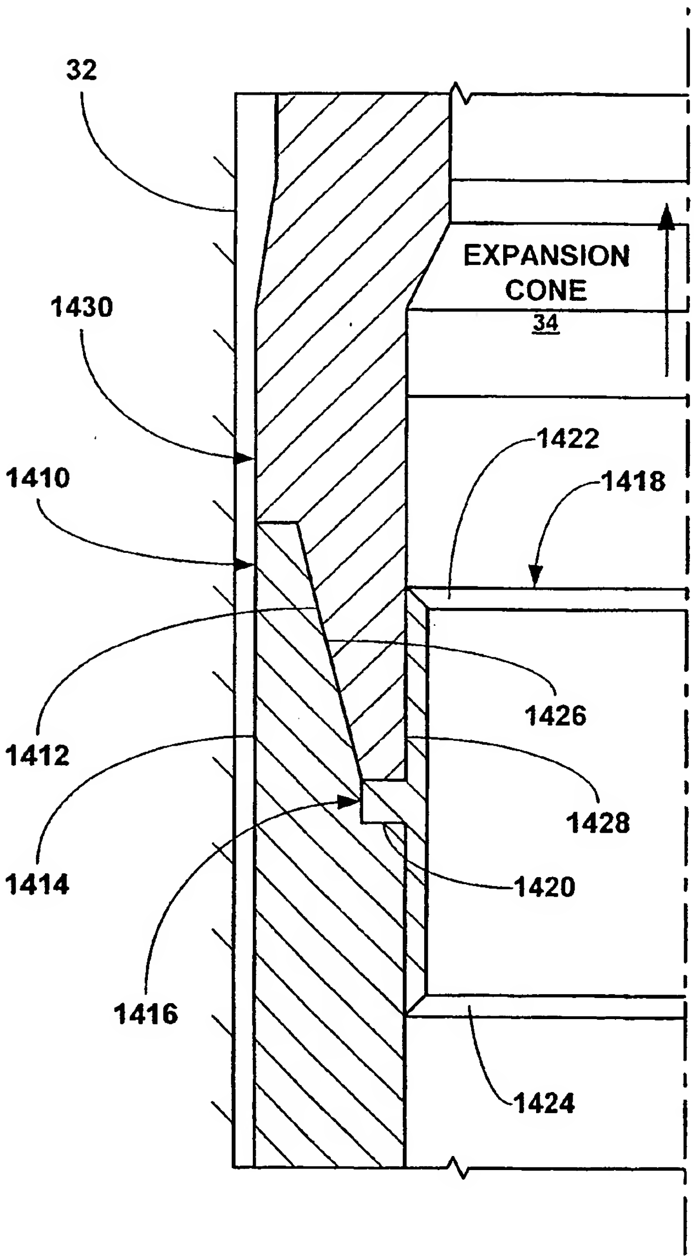
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Fig. 12e

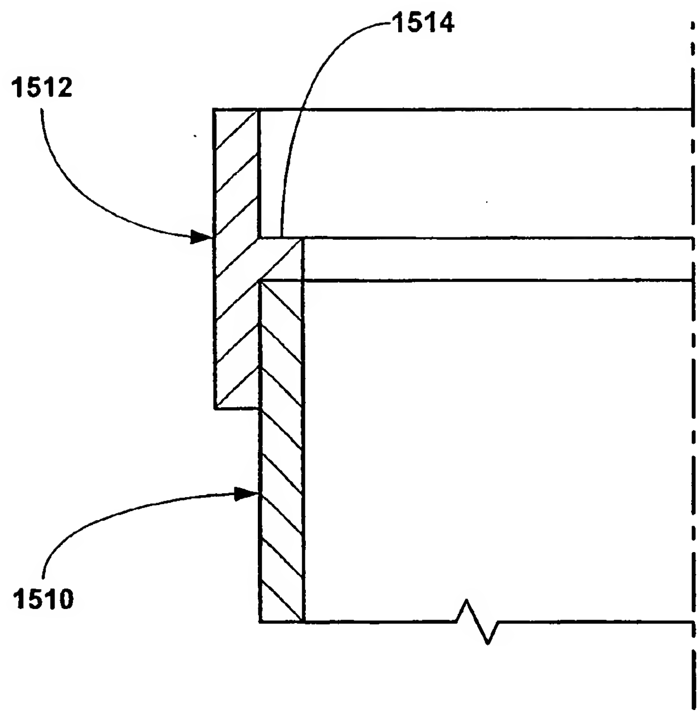

Fig. 13a

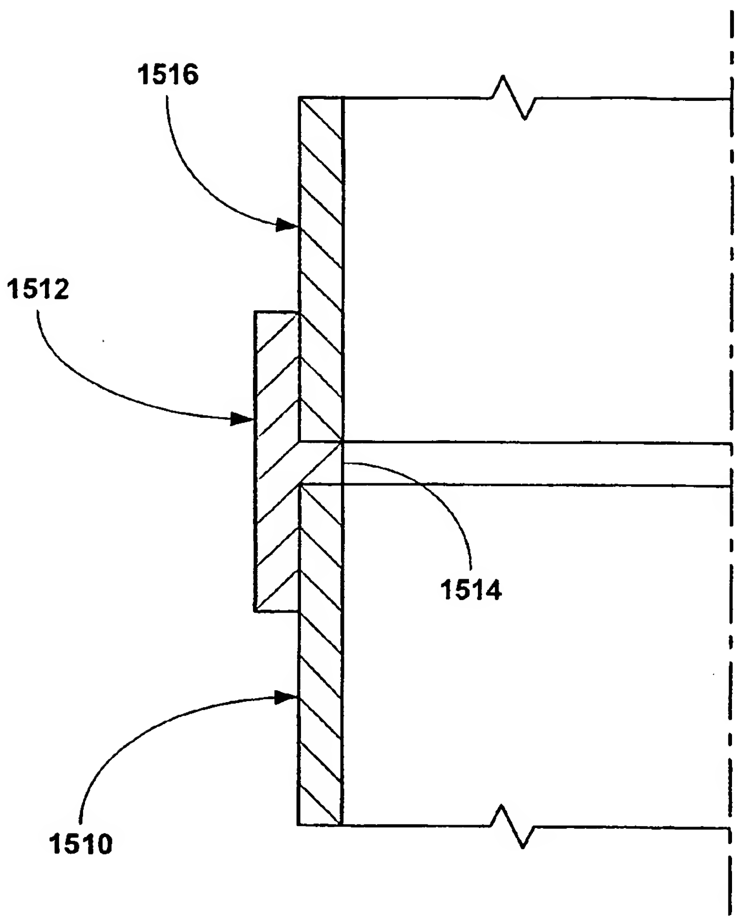

Fig. 13b

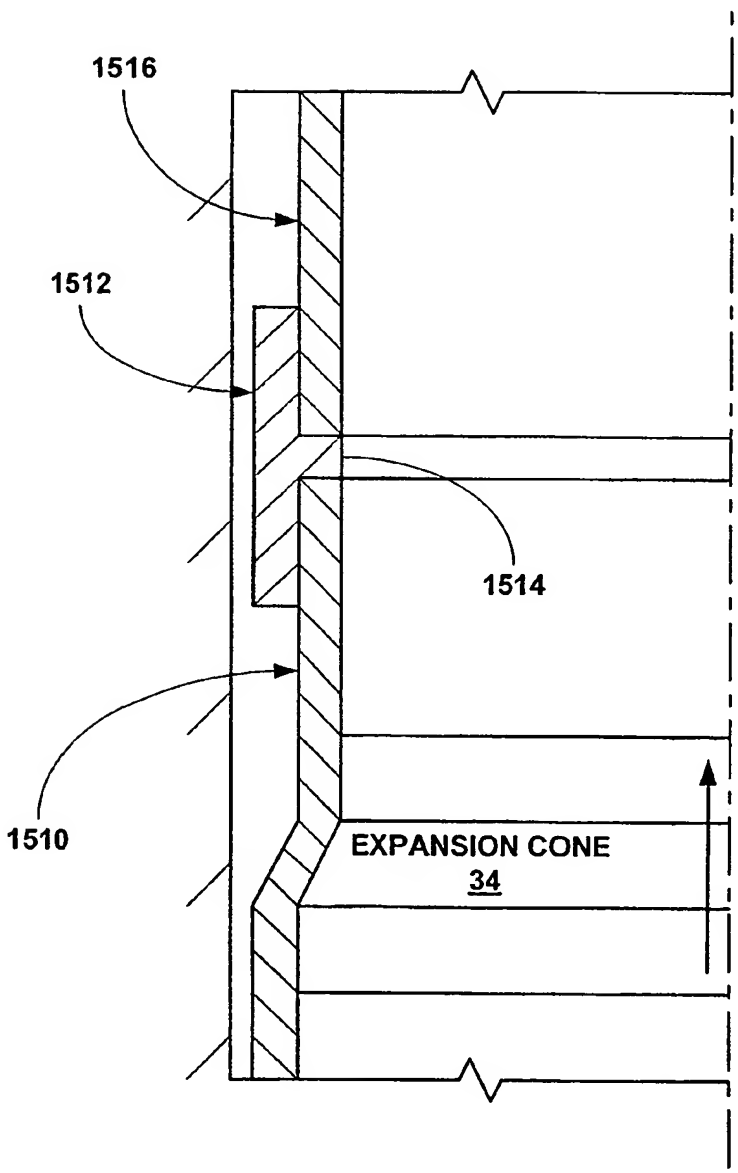

Fig. 13c

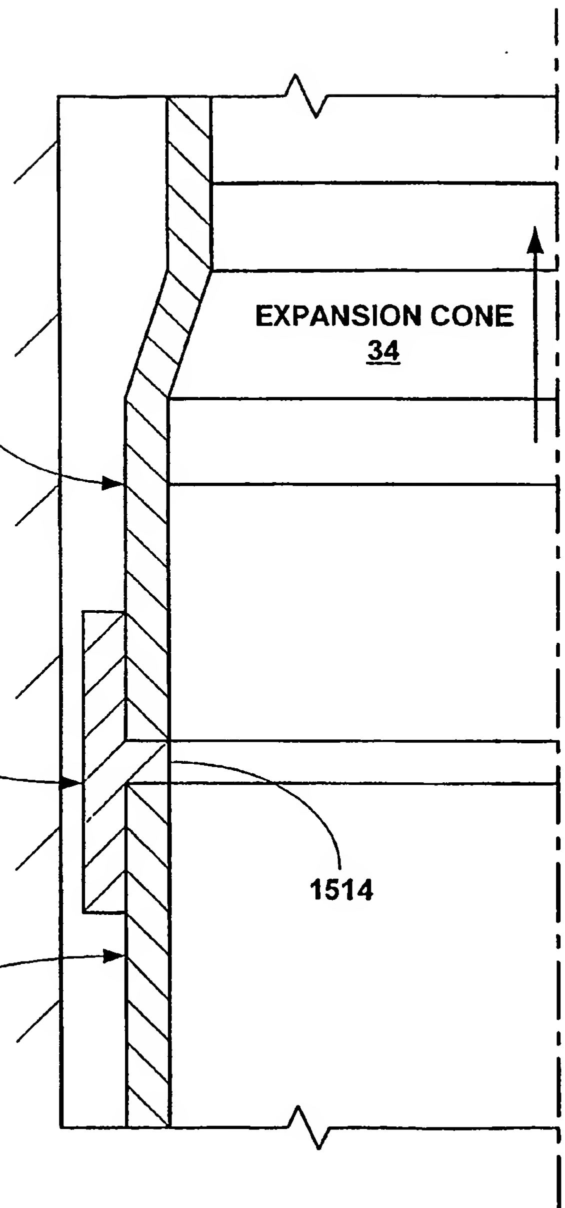

Fig. 13d

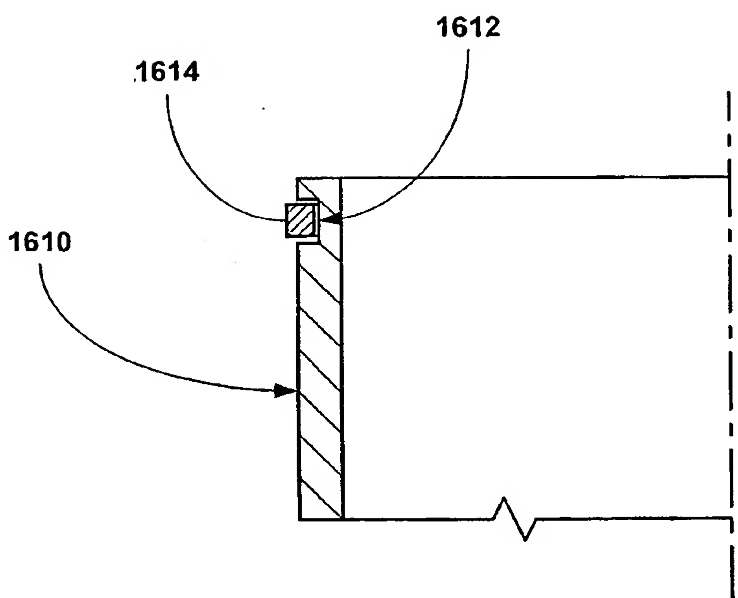

Fig. 14a

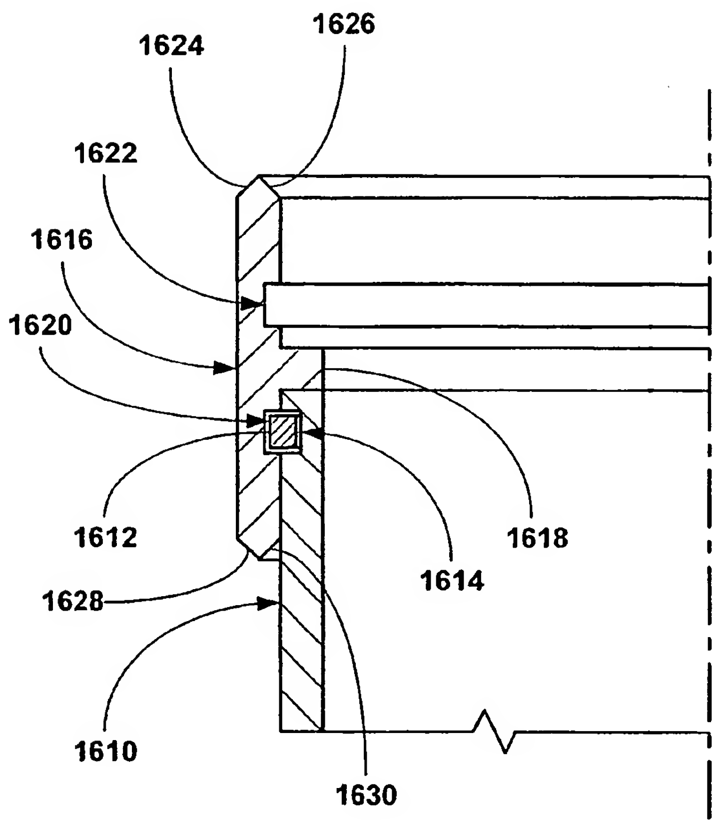

Fig. 14b

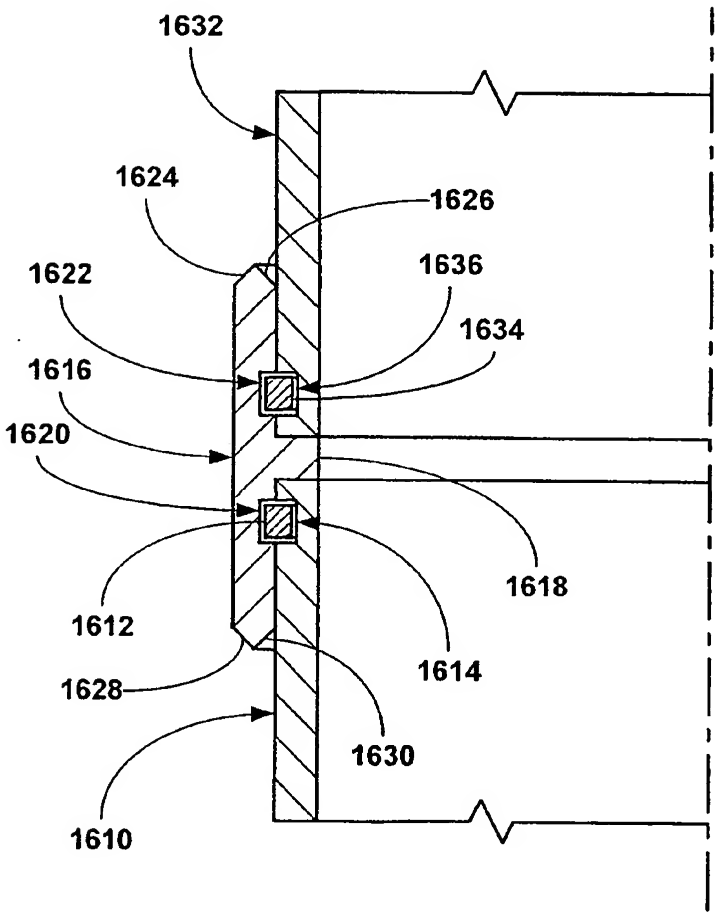
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Fig. 14c

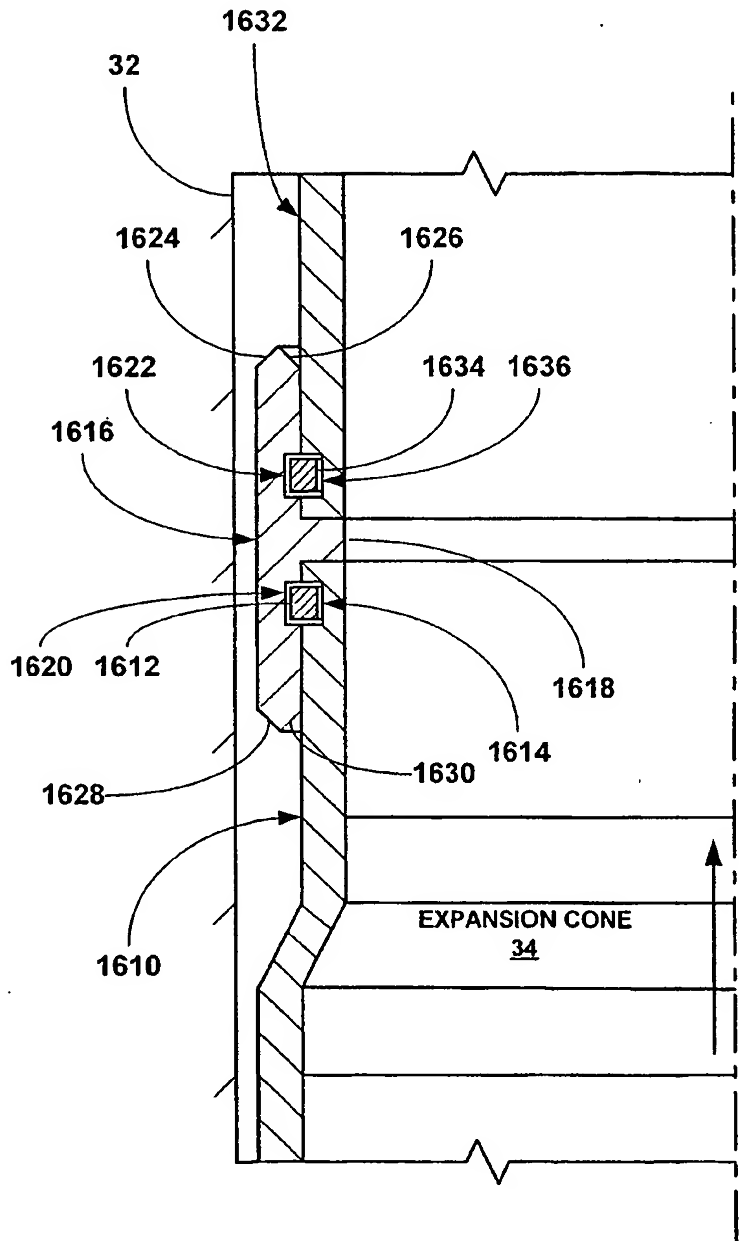
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Fig. 14d

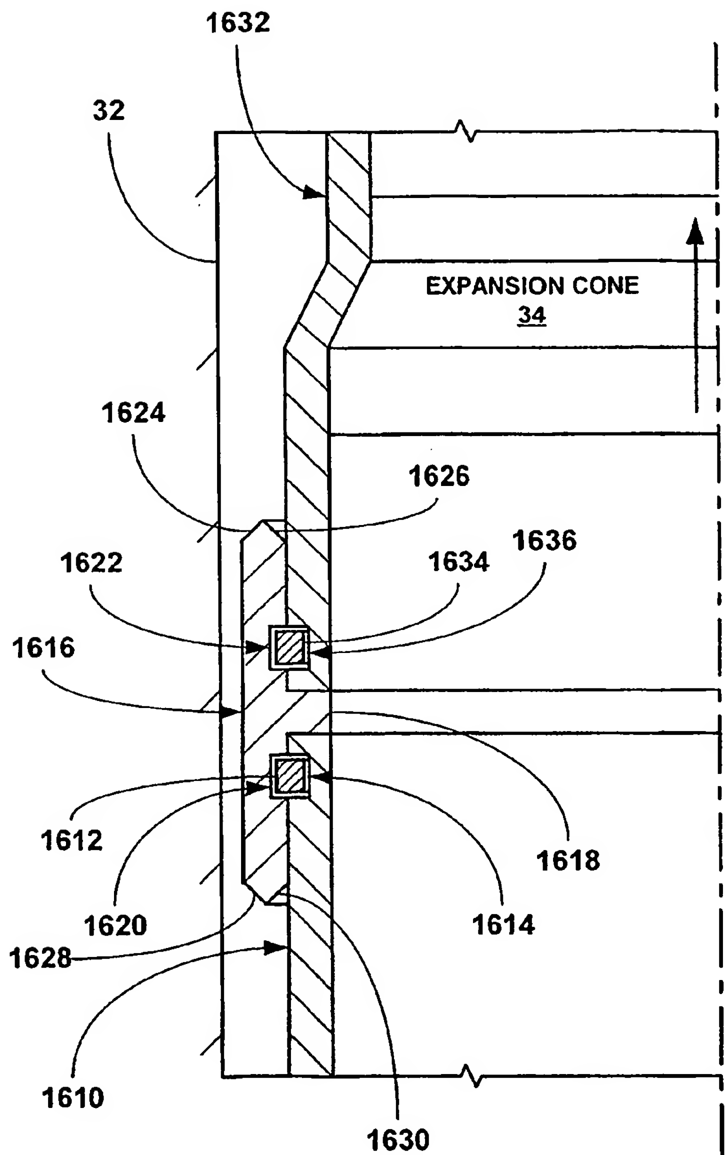
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Fig. 14e

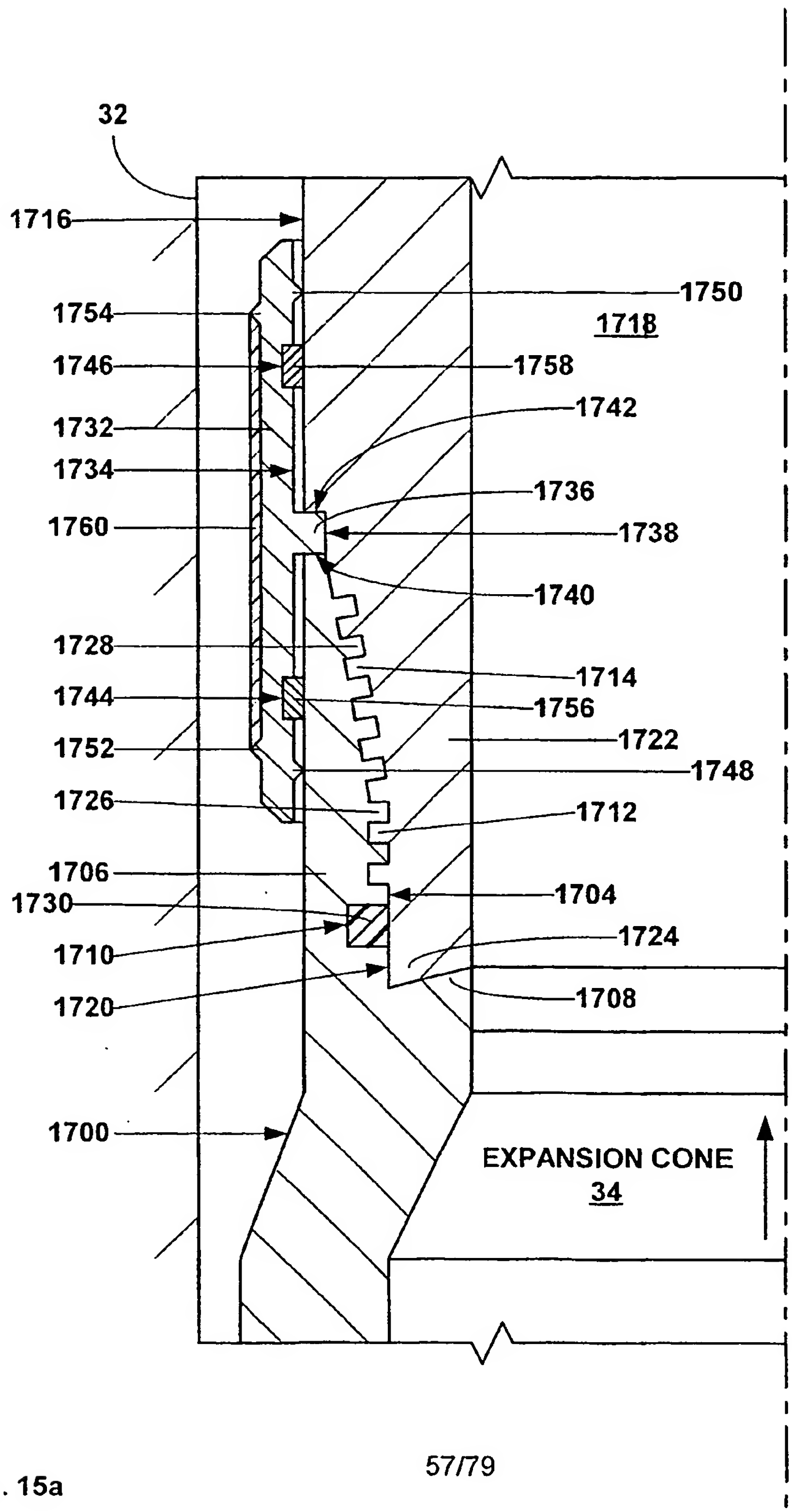
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Fig. 15a

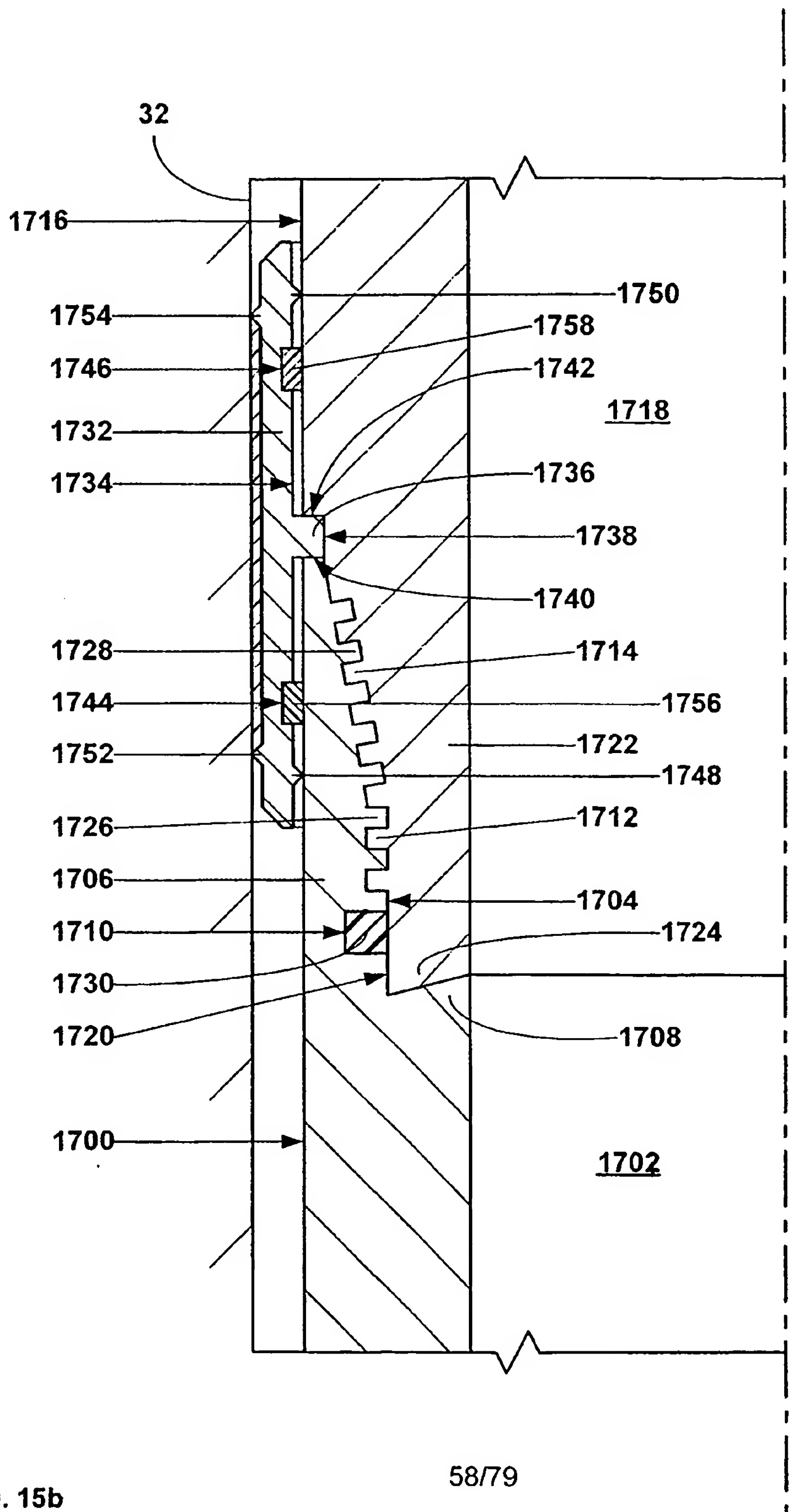
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Fig. 15b

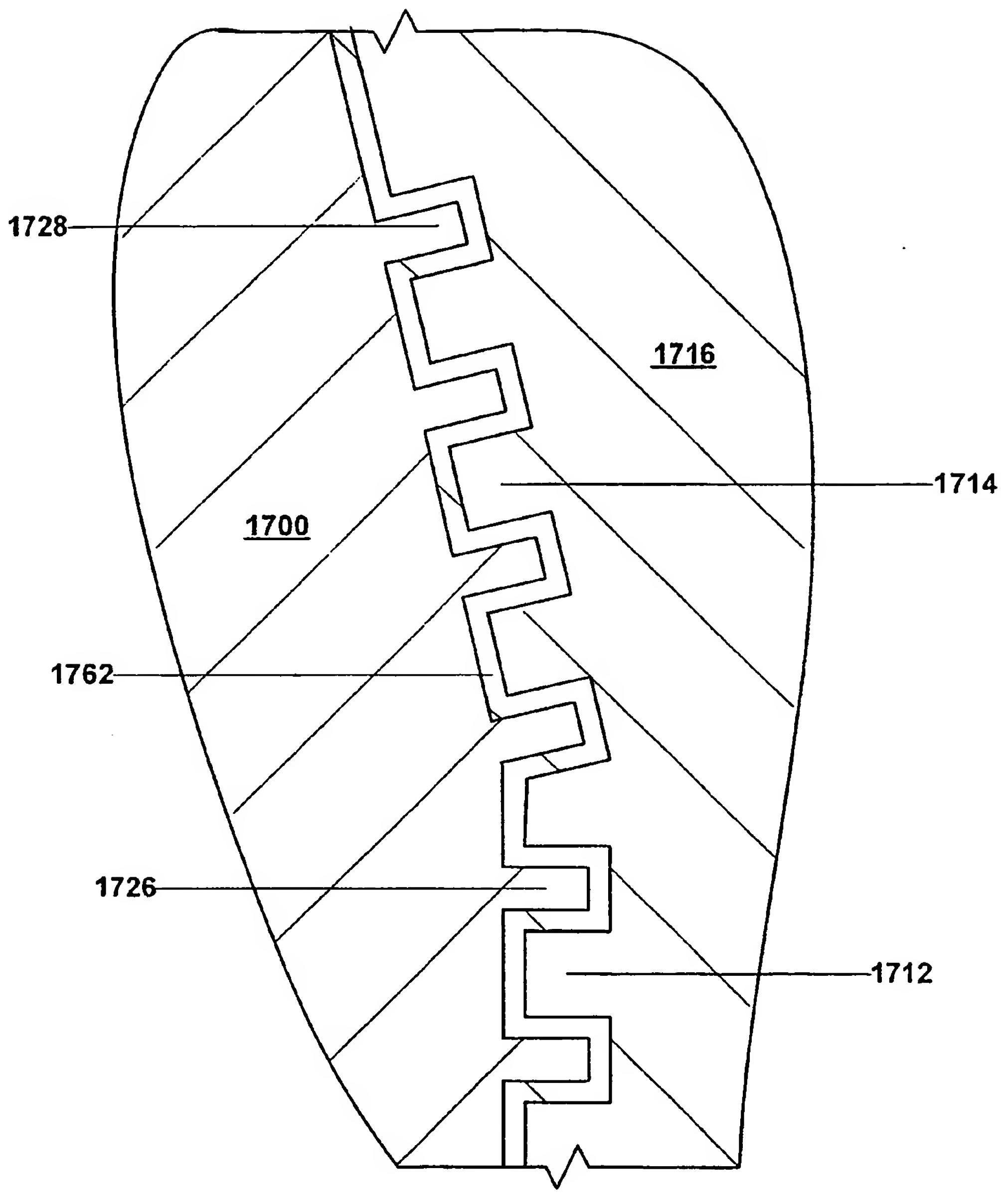

Fig. 15c

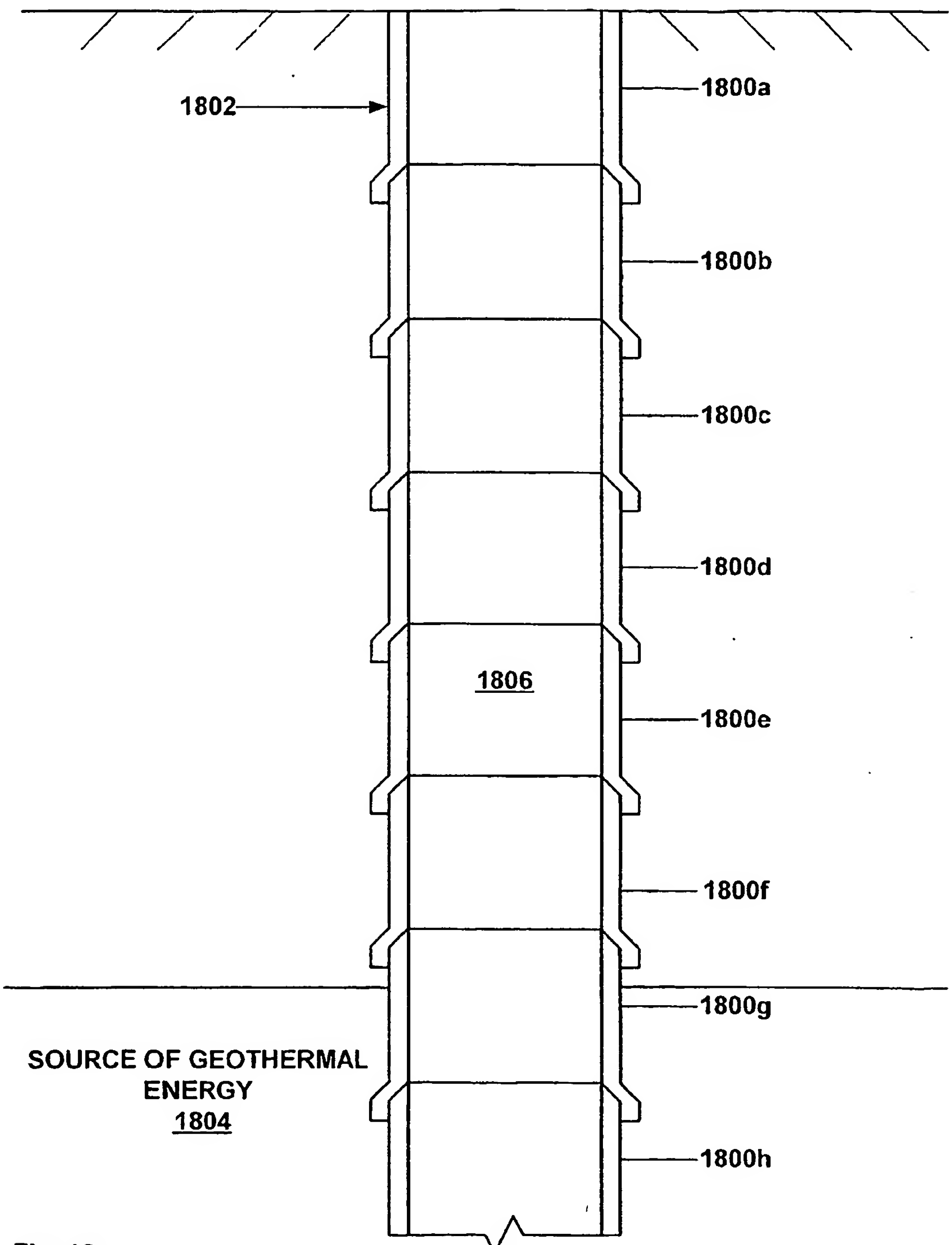
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Fig. 16

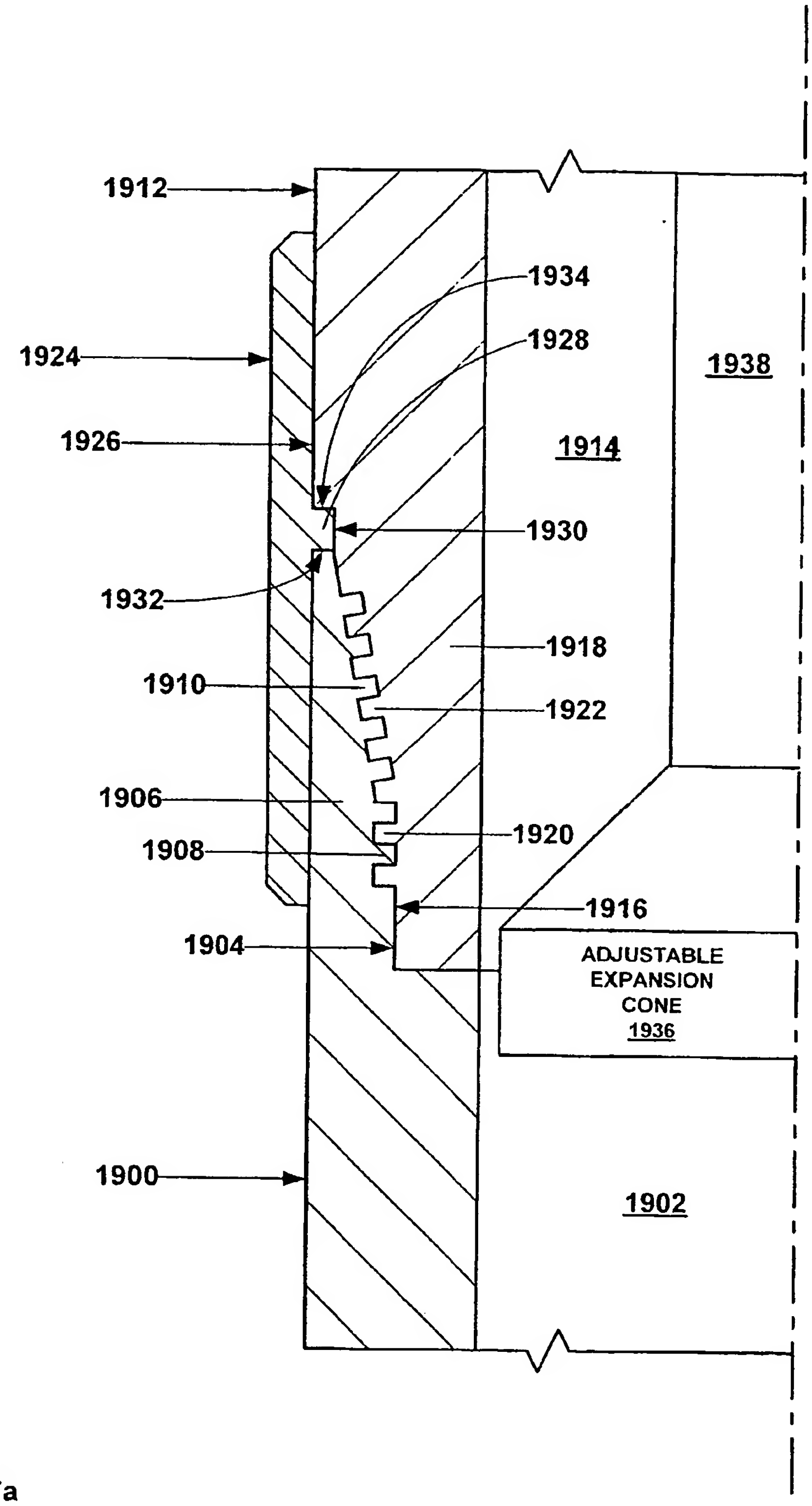
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Fig. 17a

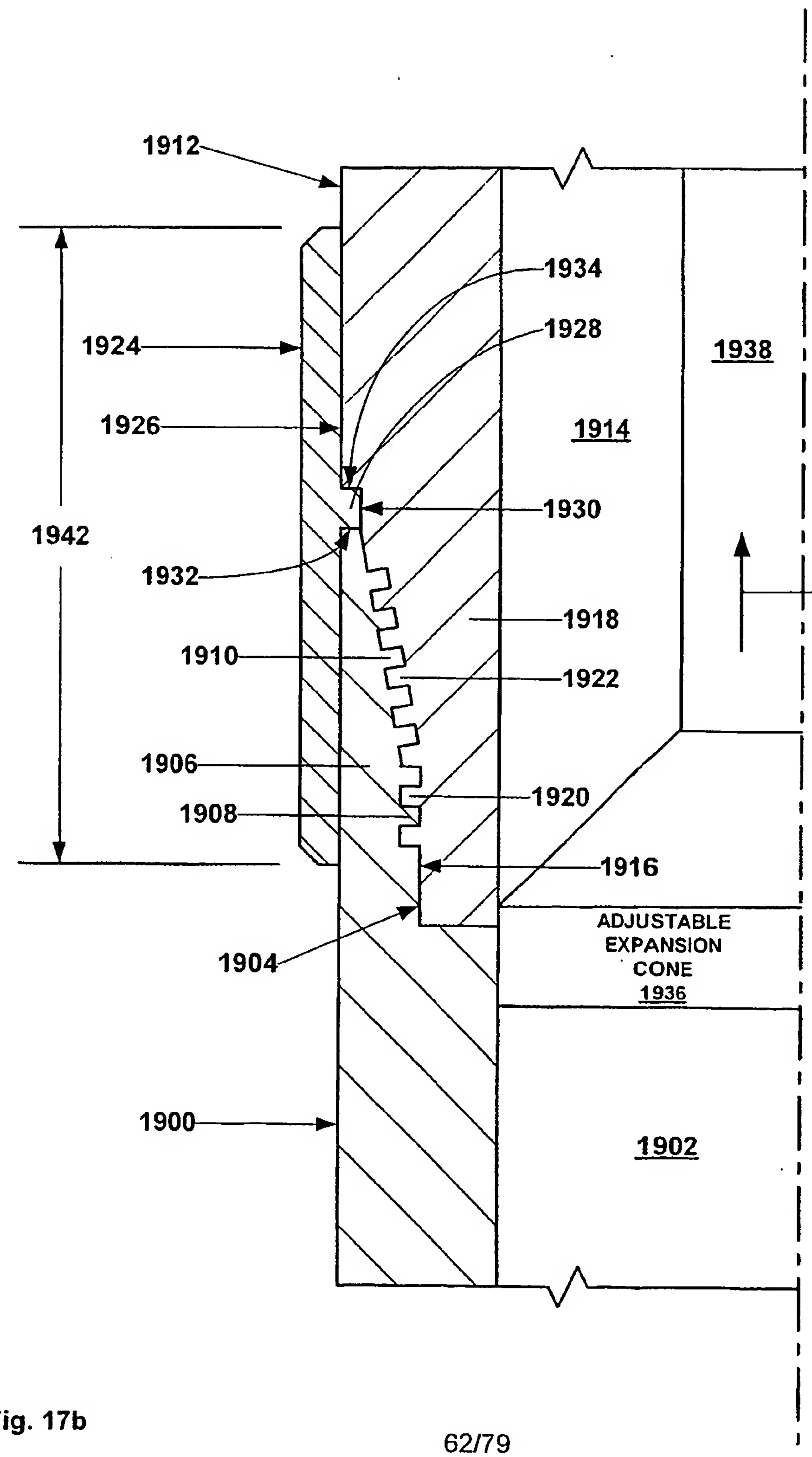
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Fig. 17b

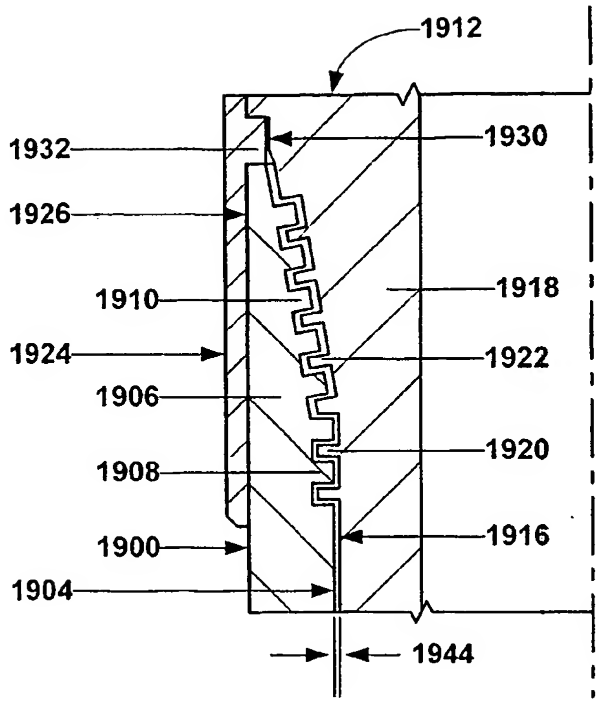

Fig. 17c

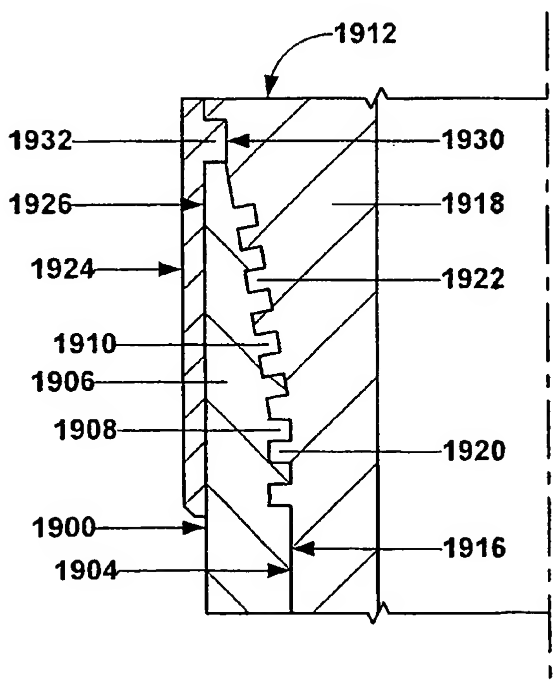

Fig. 17d

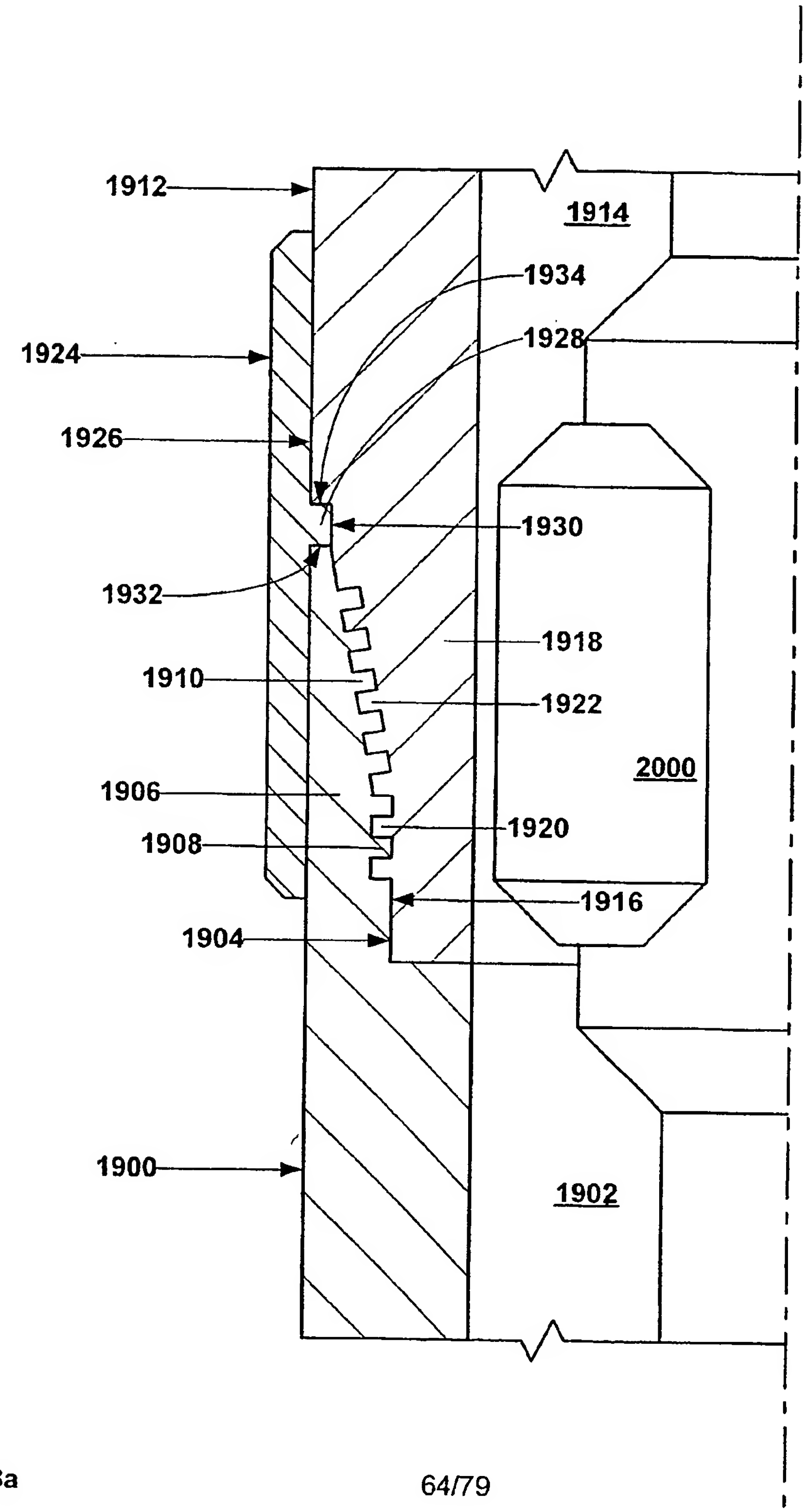
1912
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Fig. 18a

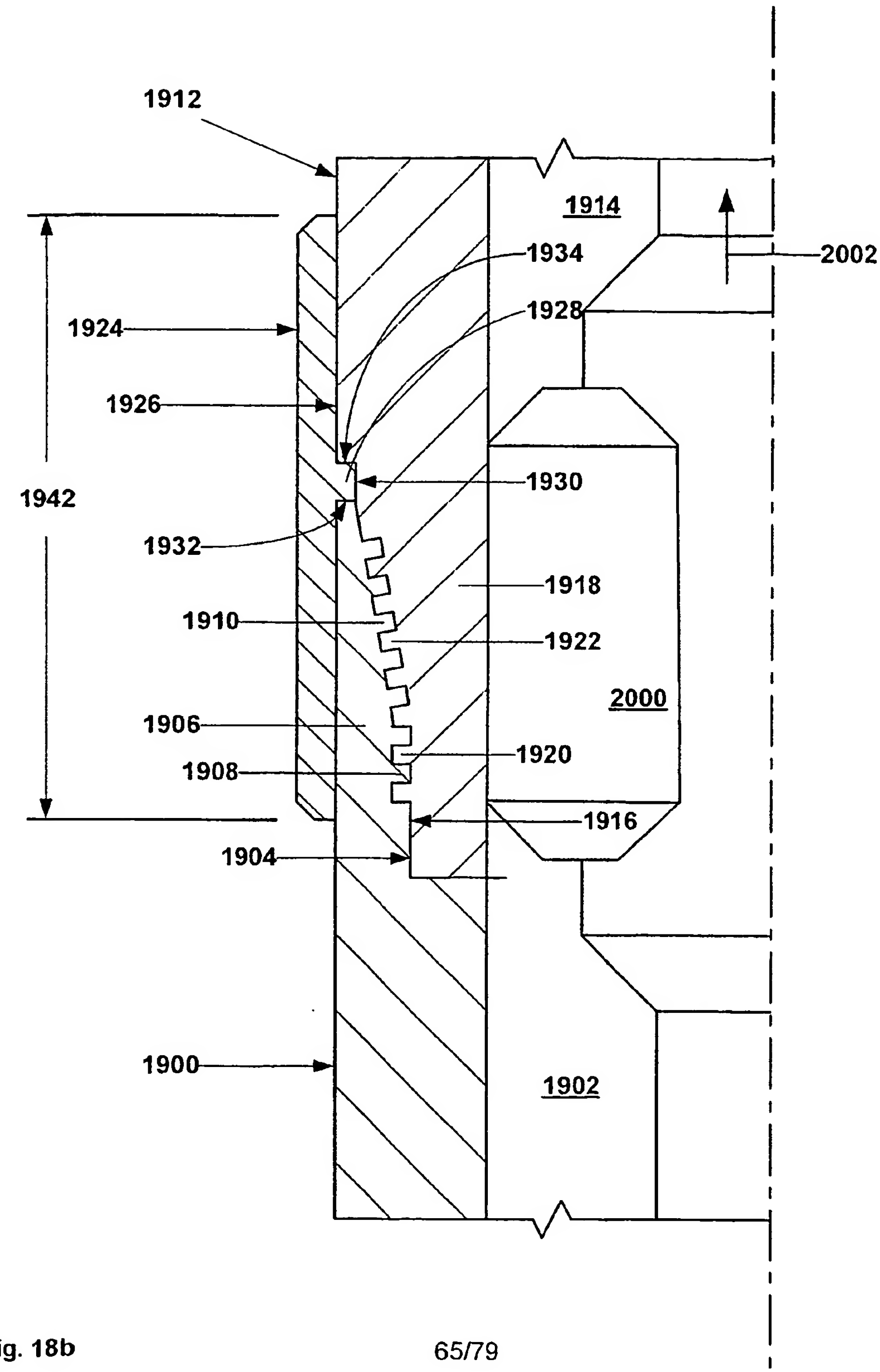
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Fig. 18b

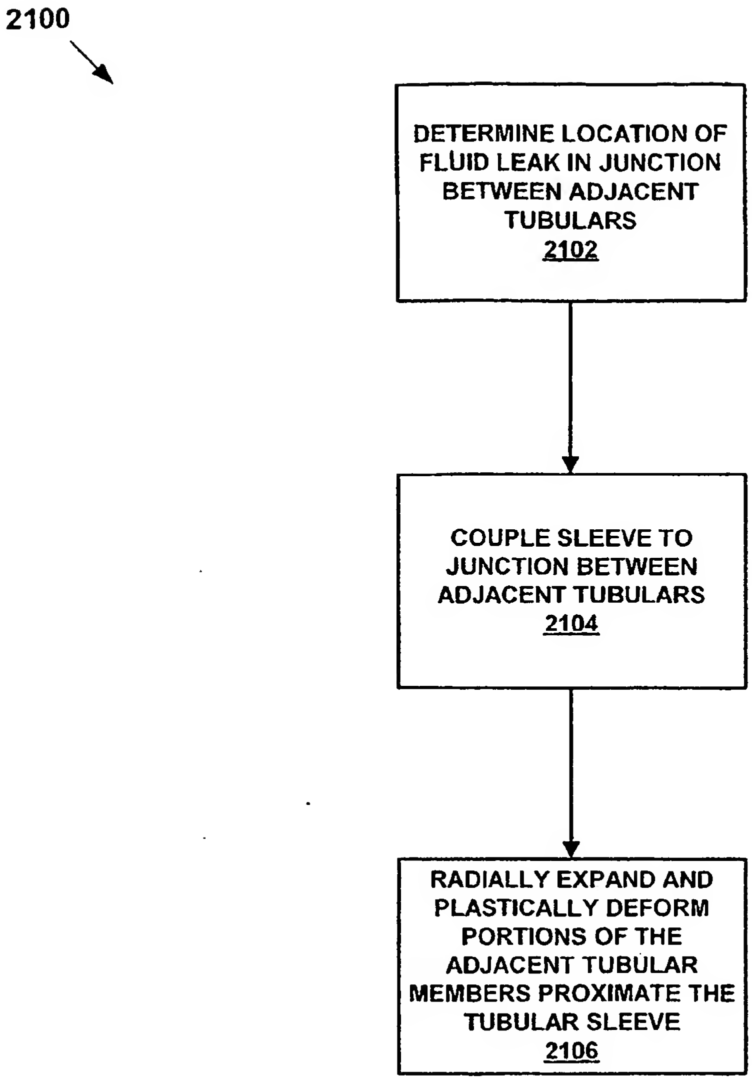
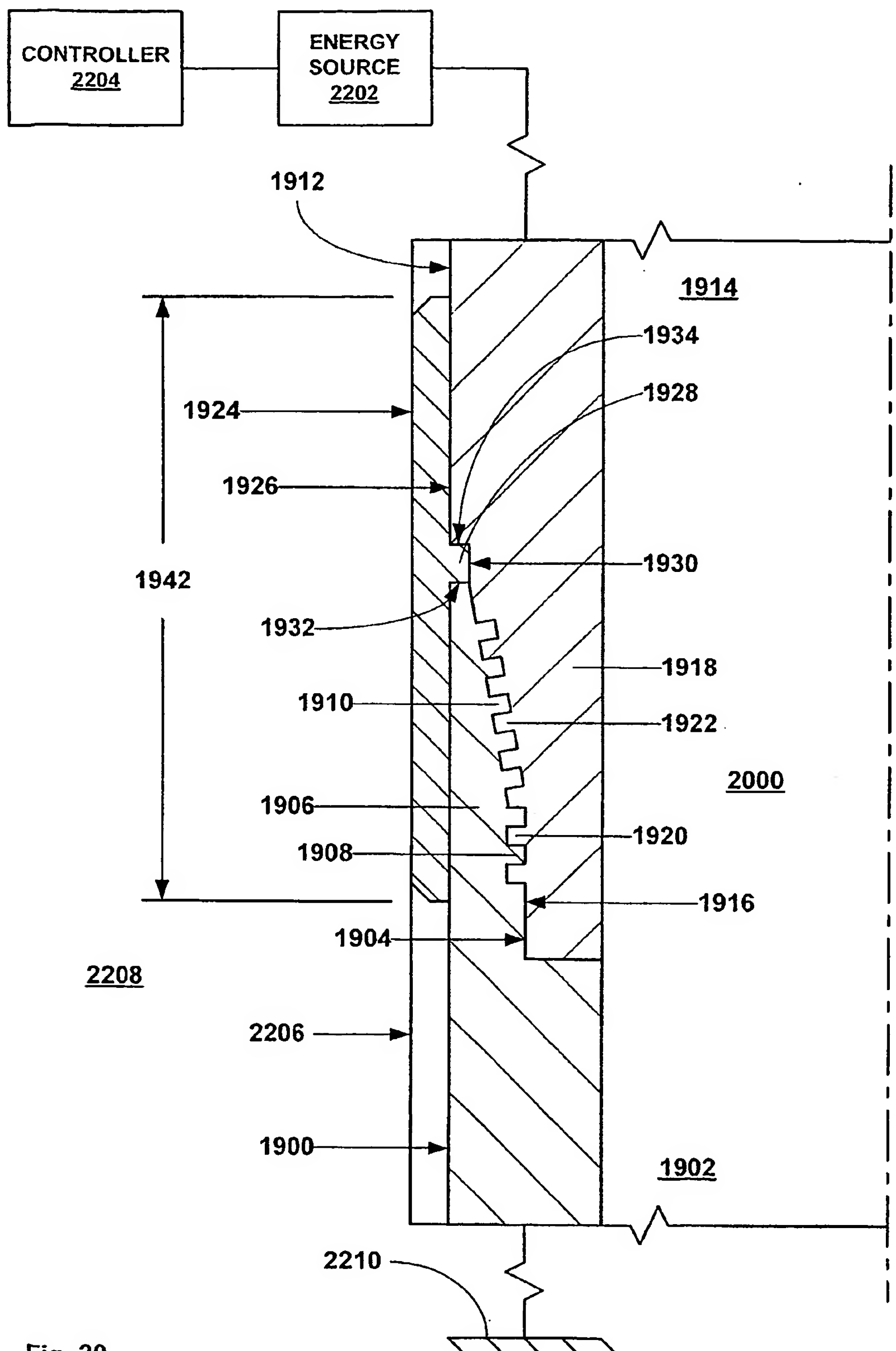

2100
DETERMINE LOCATION OF FLUID LEAK IN JUNCTION BETWEEN ADJACENT TUBULARS
2102
COUPLE SLEEVE TO JUNCTION BETWEEN ADJACENT TUBULARS
2104
RADIALLY EXPAND AND PLASTICALLY DEFORM PORTIONS OF THE ADJACENT TUBULAR MEMBERS PROXIMATE THE TUBULAR SLEEVE
2106

Fig. 19


CONTROLLER
2204
ENERGY
SOURCE
2202
1912
1914
1934
1928
1924
1926
1942
1930
1932
1918
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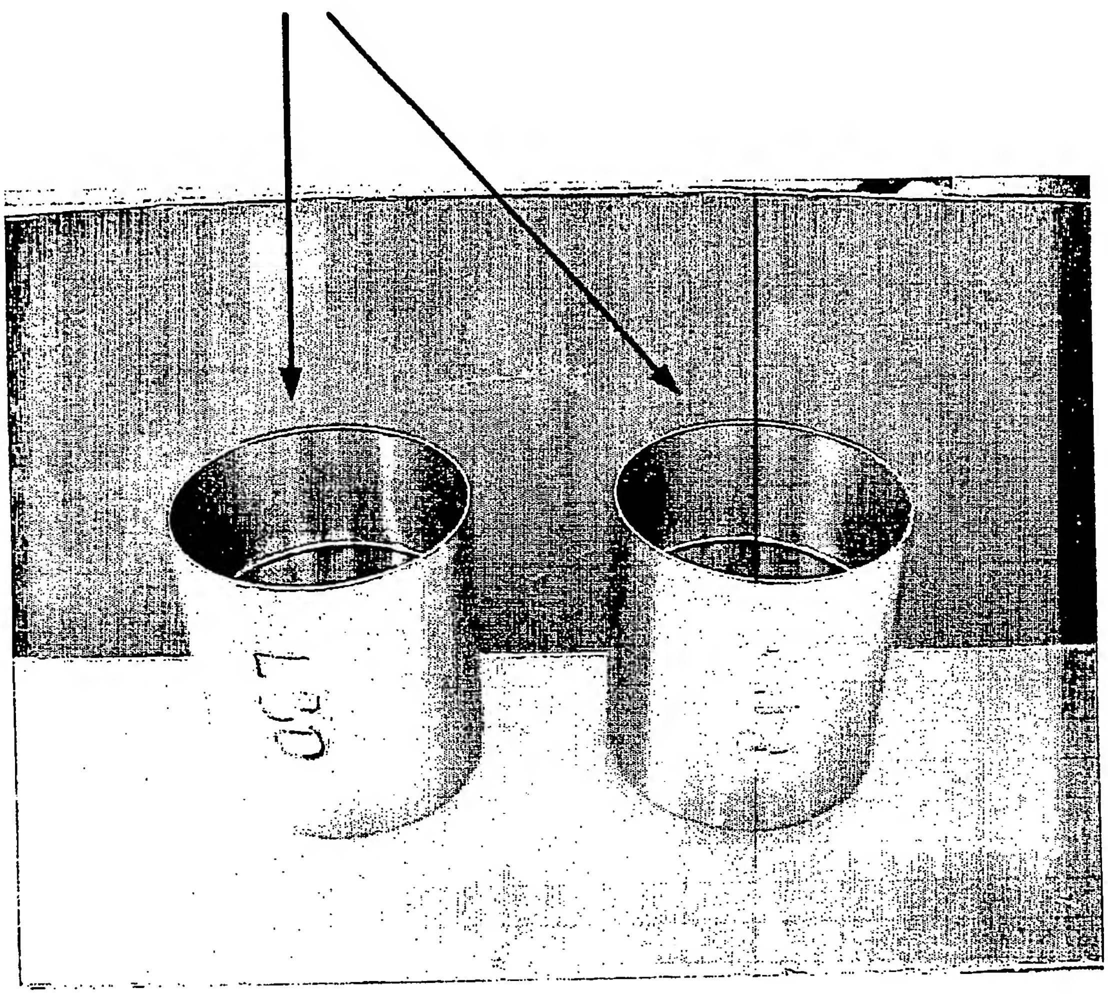
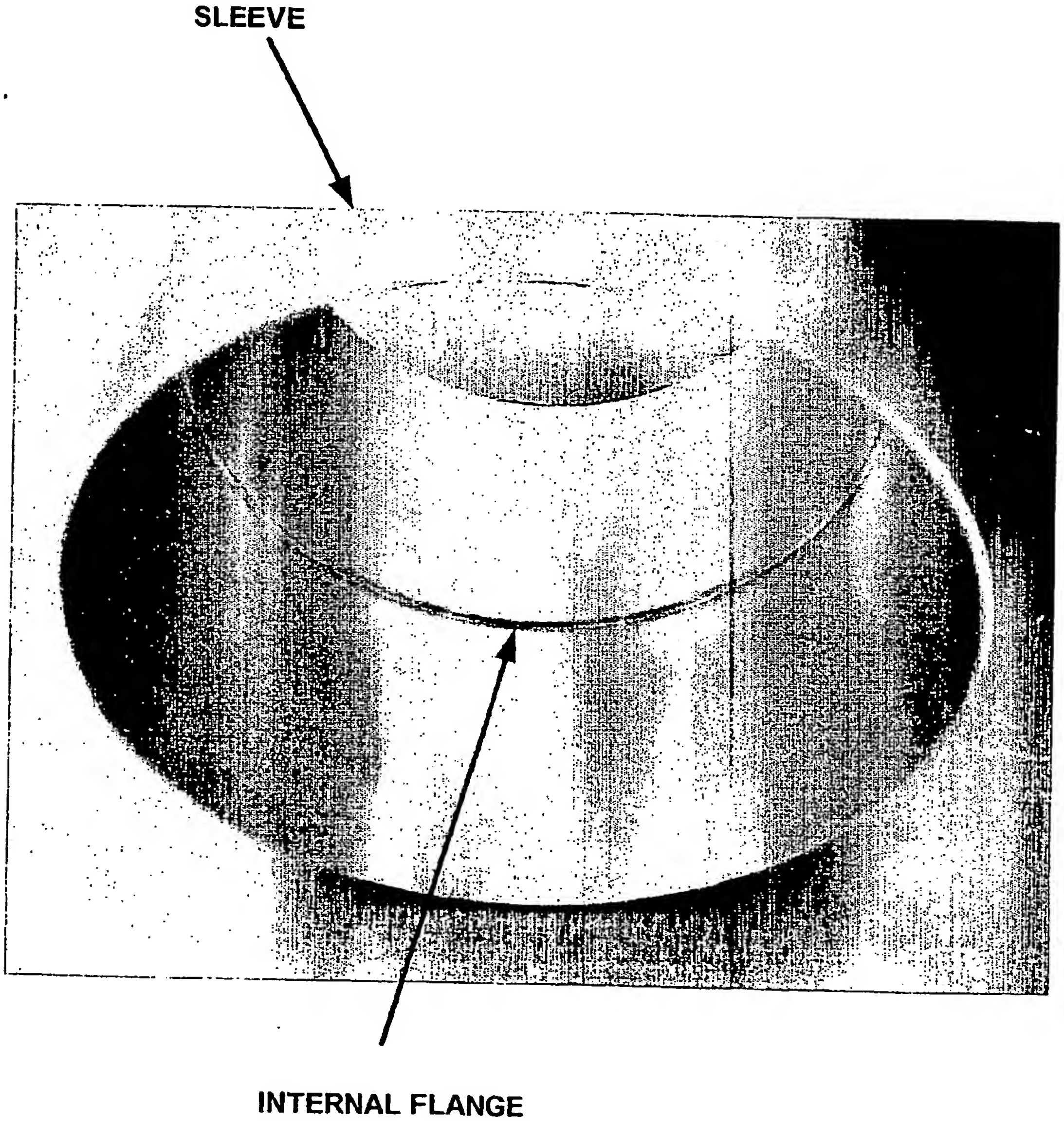
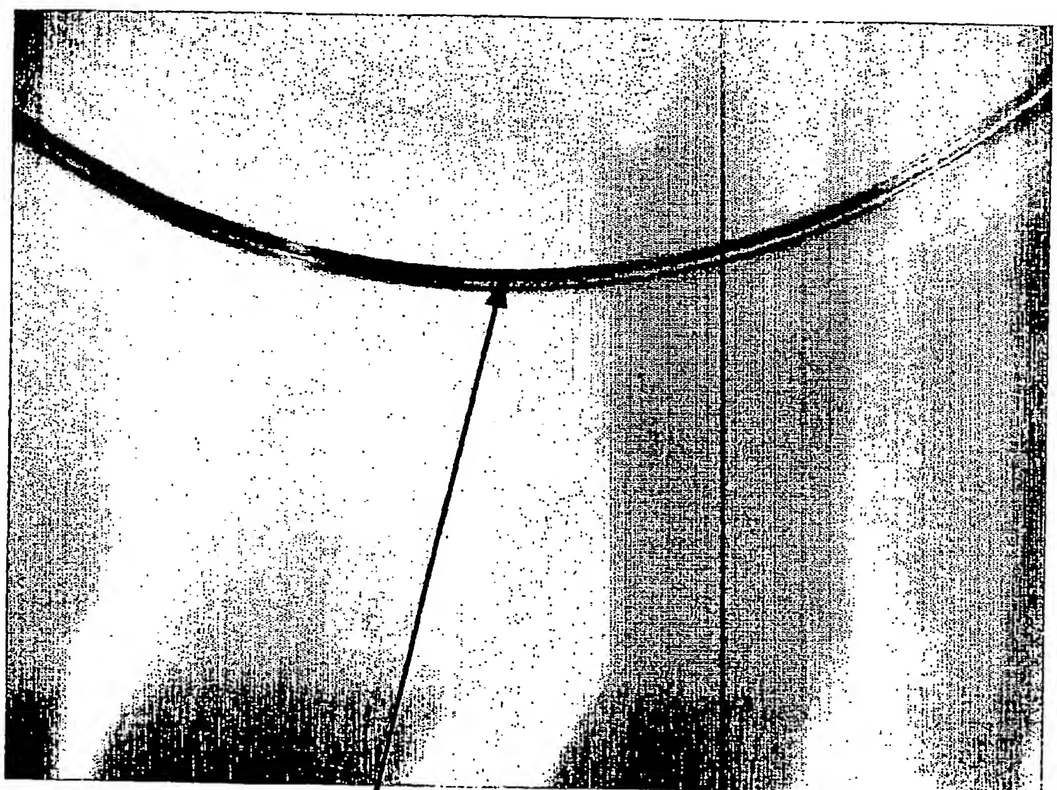
1922
2000
1906
1920
1908
1916
1904
2208
2206
1900
1902
2210

Fig. 20

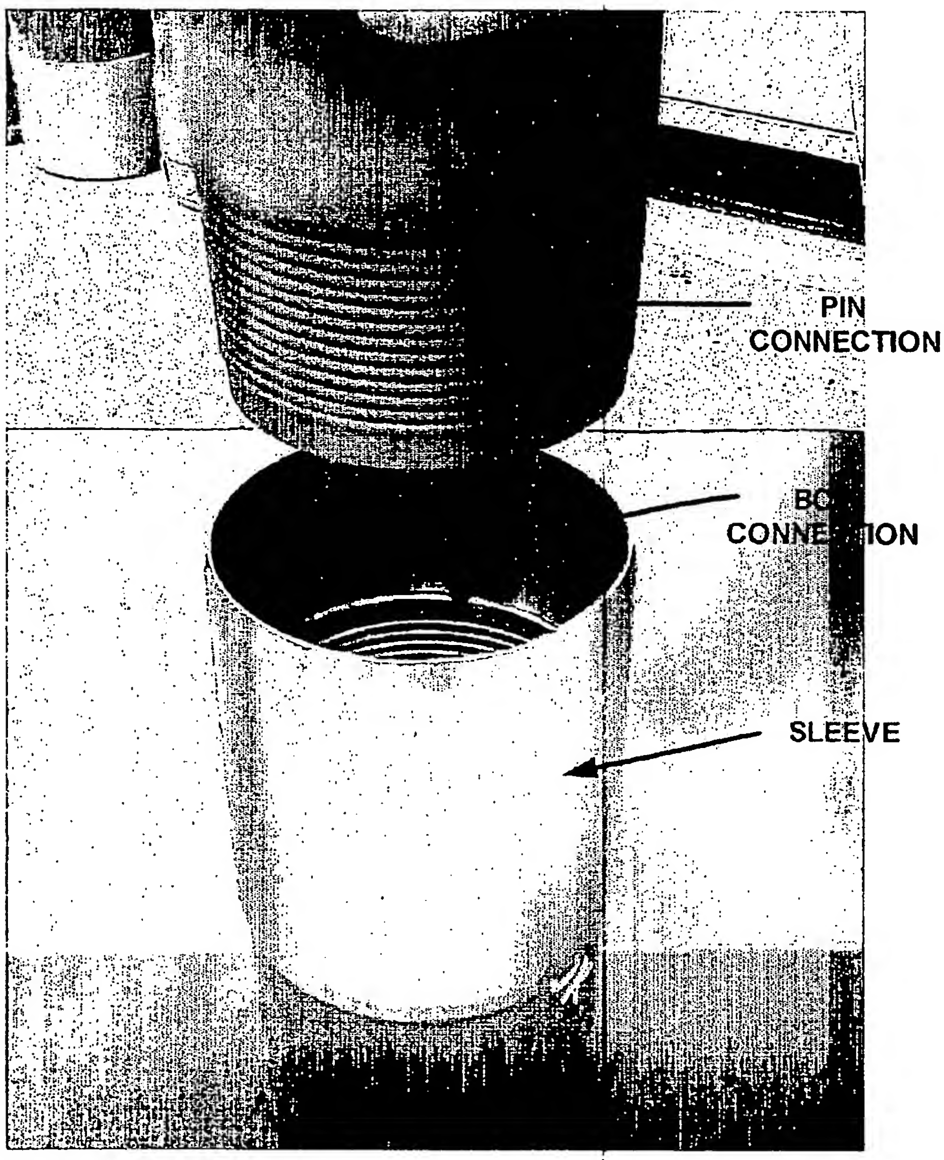
SLEEVES




SLEEVE
INTERNAL FLANGE

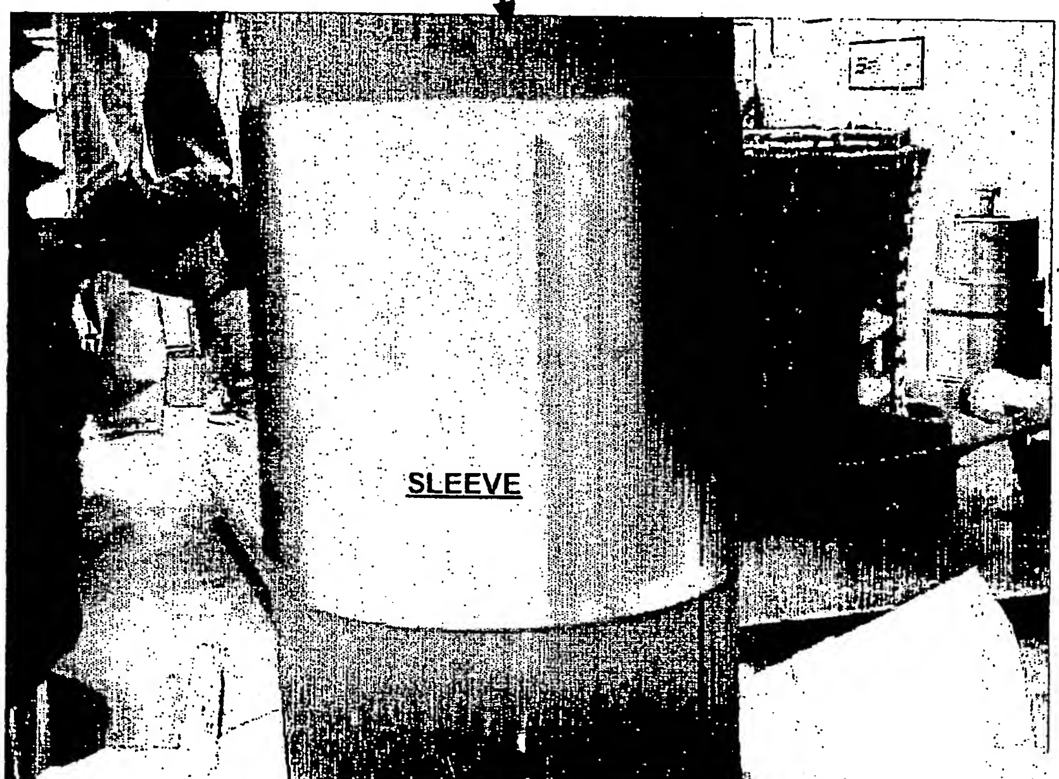


INTERNAL FLANGE

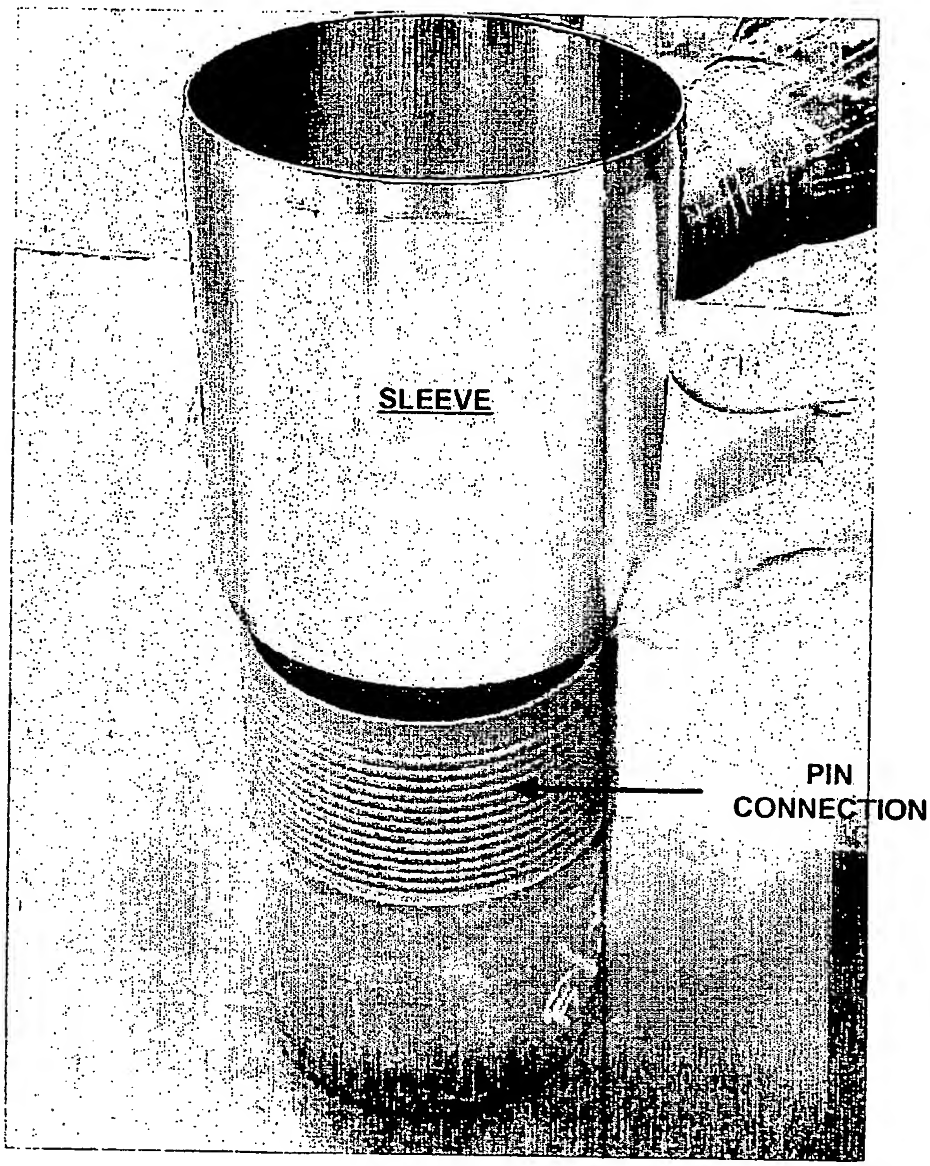

PIN
CONNECTION
SLEEVE

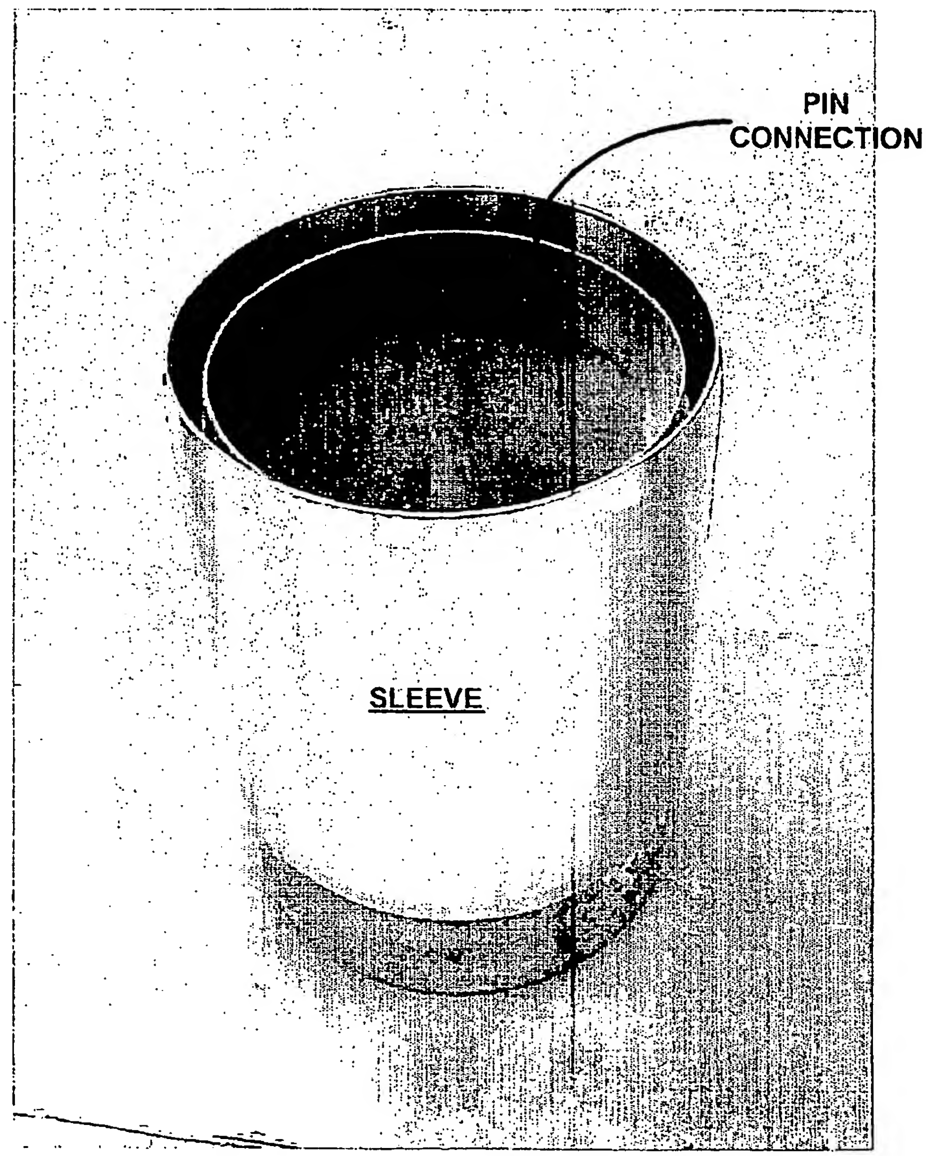
FULLY ASSEMBLED PIN AND BOX
THREADED CONNECTION WITH SLEEVE

PIN

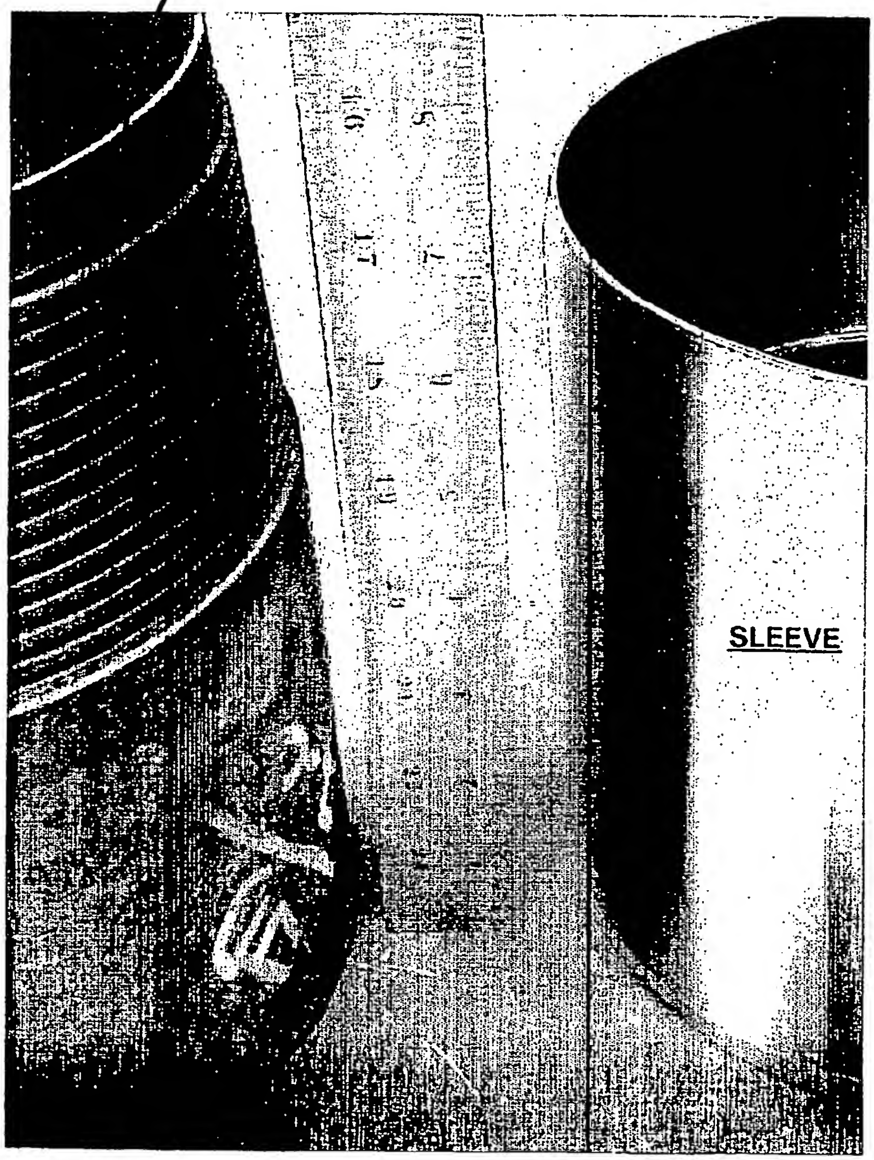


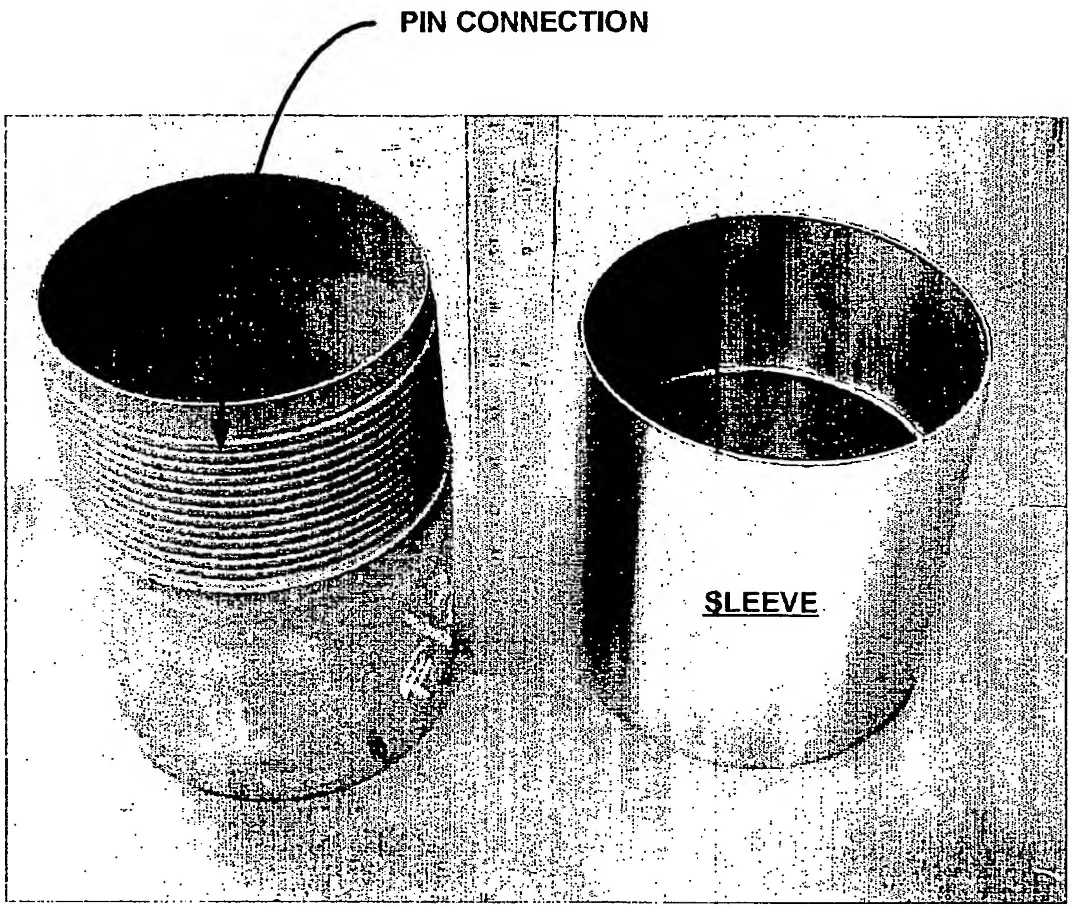
BOX


SLEEVE
PIN
CONNECTION

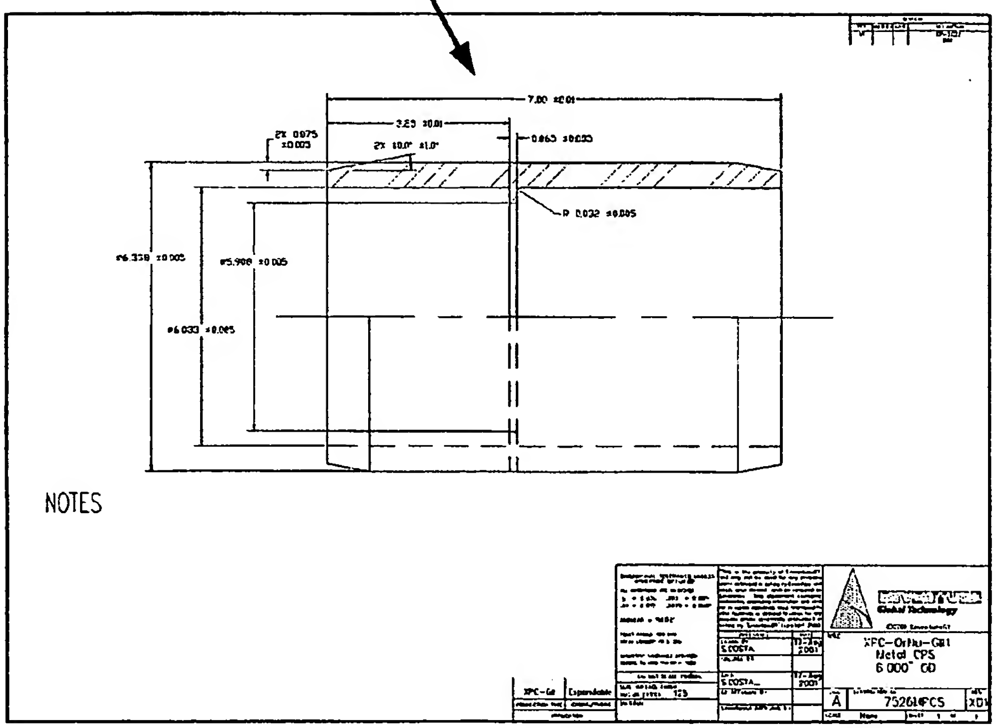

PIN
CONNECTION
SLEEVE

PIN CONNECTION

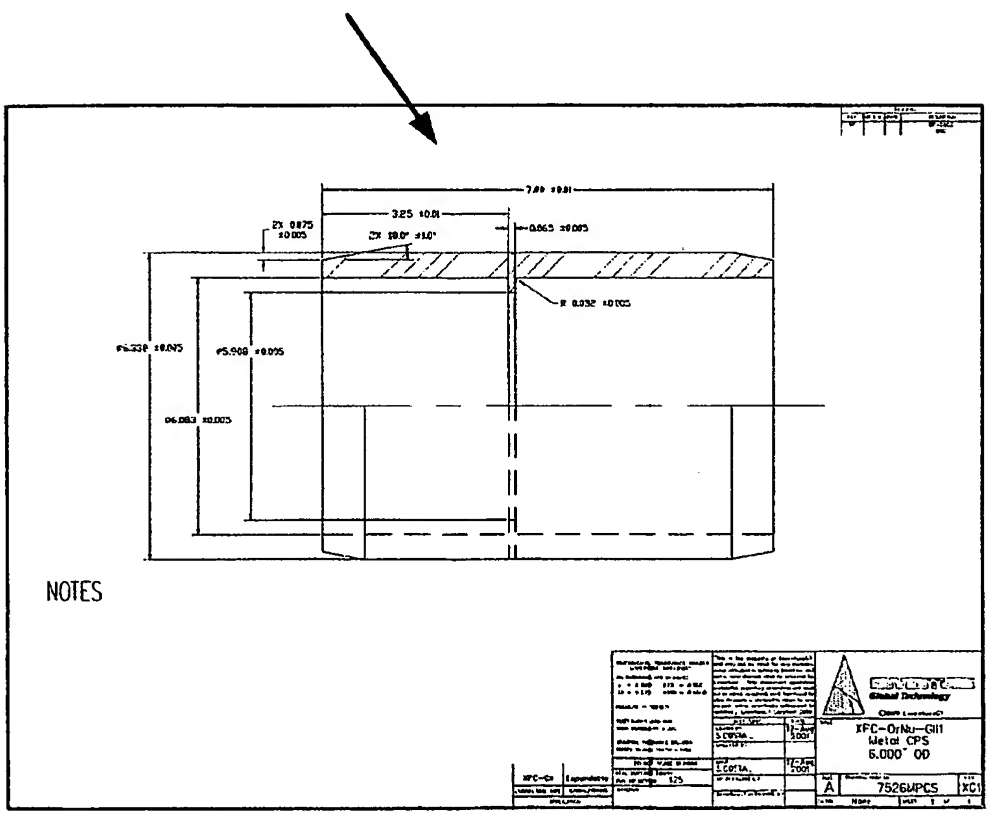



PIN CONNECTION
SLEEVE

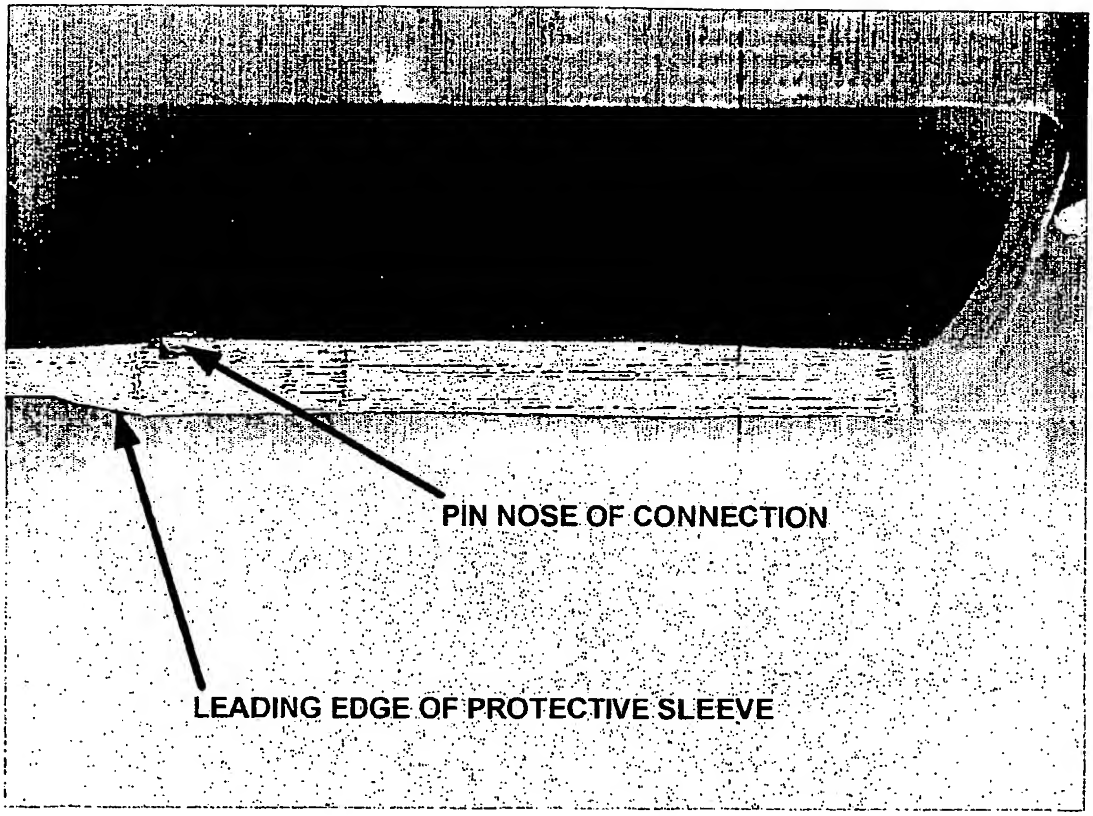
SLEEVE


7.00 ±0.01
3.25 ±0.01
0.063 ±0.030
2X 0.075 ±0.003
2X 10.0° ±1.0°
R 0.032 ±0.005
⌀6.338 ±0.005
⌀5.900 ±0.005
⌀6.033 ±0.005
NOTES
XPC-Ortho-GBI
Metal CPS
6.000" OD
75261FCS

SLEEVE


3.25 ±0.01
0.065 ±0.005
R 0.032 ±0.005
ø5.908 ±0.005
ø6.083 ±0.005
NOTES
XFC-OrNu-GII
Metal CPS
6.000" OD
A
7526MPCS

CROSS SECTIONAL VIEW OF THREADED CONNECTION AFTER RADIAL EXPANSION WITH EXTERNAL PROTECTIVE SLEEVE



(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
29 January 2004 (29.01.2004)

PCT

(10) International Publication Number
WO 2004/010039 A3

(51) International Patent Classification[7]: E21B 19/16, 7/00, 29/10, F16L 21/00

(21) International Application Number: PCT/US2003/019993

(22) International Filing Date: 24 June 2003 (24.06.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/397,284 19 July 2002 (19.07.2002) US

(71) Applicant (*for all designated States except US*): **ENVENTURE GLOBAL TECHNOLOGY** [US/US]; 16200 A Park Row, Houston, TX 77084 (US).

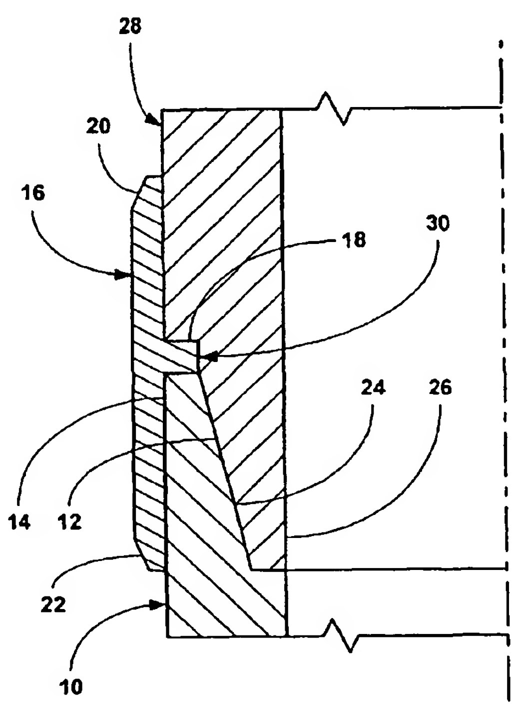
(72) Inventors; and
(75) Inventors/Applicants (*for US only*): **COSTA, Scott** [US/US]; 2011 Willow Point, Kingwood, TX 77339 (US). **HOCKADAY, Joel** [US/US]; 17318 Ginger Fields Lane, Tomball, TX 77375 (US). **WADDELL, Kevin, K.** [US/US]; 11007 Sprucedale Court, Houston, TX 77070 (US). **RING, Lev** [RU/US]; 14126 Heatherhill Place, Houston, TX 77077 (US). **BULLOCK, Michael** [US/US]; 19827 Sky Country, Houston, TX 77094 (US). **COOK, Robert, Lance** [US/US]; 934 Caswell Court, Katy, TX 77450 (US). **KENDZIORA, Larry** [US/US]; 6518 Williams School Court, Needville, TX 77461 (US). **BRISCO, David, Paul** [US/US]; 405 Westridge Drive, Duncan, OK 73533 (US). **JACKSON, Tance** [US/US]; 7209 Ridgemoor Lane, Plano, TX 75025 (US). **RAO, Vikram** [US/US]; 6429 Edloe, Houston, TX 77005 (US).

(74) Agents: **MATTINGLY, Todd** et al.; Haynes and Boone, LLP, 1000 Louisiana, Suite 4300, Houston, TX 77002-5012 (US).

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU,

[Continued on next page]

(54) Title: PROTECTIVE SLEEVE FOR THREADED CONNECTIONS FOR EXPANDABLE LINER HANGER



(57) Abstract: A tubular sleeve (16) is coupled to and overlaps the threaded connection between a pair of adjacent tubular members (10 and 28). The adjacent tubular members (10 and 28) are then radially expanded and plastically deformed.

WO 2004/010039 A3

CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) **Designated States** *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declaration under Rule 4.17:
— *of inventorship (Rule 4.17(iv)) for US only*

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

(88) **Date of publication of the international search report:** 8 July 2004

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/19993

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : E21B 19/16,7/00,29/10; F16L 21/00

US CL : 166/380,277,242.2,250.08;175/40,57;285/370;73/152.54

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : Please See Continuation Sheet

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Continuation Sheet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2002/0066578 A1 (Broome) 06 June 2002 (06.06.2002), see Figures.	1,6-9,16-18,28-38,43-46,50-53,58,59,61,63,64,76-85,92-94,104-109,114,115,118,119,125,127 ---------- 2-5,10-15,19-24,39-41,49,54-57,86-91,95-100,110-112,128-130,132,134-137,139,141-166

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search 17 December 2003 (17.12.2003)	Date of mailing of the international search report 24 MAY 2004
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703)305-3230	Authorized officer David Bagnell FOR Telephone No. (703) 308-1113

INTERNATIONAL SEARCH REPORT

PCT/US03/19993

C. (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 4,328,983 A (Gibson) 11 May 1982 (11.05.1982), see Figures.	10-15,19-24,60,62,64-75,85-91,95-100,120-124,126 ---------- 39-41,110-112,131,133,138,140
Y	US 5,975,587 A (Wood et al.) 02 November 1999 (02.11.1999), see Figures and Abstract.	39-41,110-112
Y	US 5,862,866 A (Springer) 26 January 1999 (26.01.1999), see col. 8, lines 40-60.	128-141,159-166
Y	US 5,584,512 A (Carstensen) 17 December 1996 (17.12.1996), see col. 6, lines 25-55.	142-151
A	US 6,406,063 B1 (Pfeiffer) 18 June 2002 (18.06.2002), see Figures.	1-166
A	US 5,360,239 A (Klementich) 01 November 1994 (01.11.1994), see Figures.	1-166
A	US 5,895,079 A (Carstensen et al.) 20 April 1999 (20.04.1999), see Figures.	1-166
A	US 6,231,086 B1 (Tierling) 15 May 2001 (15.05.2001), see Figures.	1-166
A	US 4,832,382 A (Kapgan) 23 May 1989 (23.05.1989), see Figures.	1-166

INTERNATIONAL SEARCH REPORT

PCT/US03/19993

BOX II. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claim(s) 1-63 and145-166, drawn to a method for coupling tubulars and expanding the tubulars.

Group II, claim(s) 64-127, drawn to a tubing coupling.

Group III, claim(s) 128-140, drawn to a method and apparatus for extracting geothermal energy from a subterranean source of geothermal energy.

Group IV, claim(s) 142-144, drawn to a method for pressure testing tubing.

The inventions listed as Groups I-IV do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: Group I is not required to be used in a pressure testing procedure or in the extracting of geothermal energy. Group II does not include expanding the tubing coupling and is not required to be used in a pressure testing procedure or in the extracting of geothermal energy. Group III does not include the pressure testing procedure. Group IV is not used in the extraction of geothermal energy nor does it include the specifics of the tubing coupling.

Continuation of B. FIELDS SEARCHED Item 1:

166/380,277,242.2,250.08,207,208,242.1,242.6,269,250.01,66;175/40,57,24;285/370,65,66,328,330,332,334.1,334.5,345,363,369,371,365,405,407;73/152.54,152.51,152.55

Continuation of B. FIELDS SEARCHED Item 3:

EAST

search terms: sleeve, flange, lip, shoulder, wellbore, threaded coupling, threaded connector, geothermal, pressure testing

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/19993

Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claim Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
Please See Continuation Sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest ☐ The additional search fees were accompanied by the applicant's protest.
☐ No protest accompanied the payment of additional search fees.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
29 January 2004 (29.01.2004)

PCT

(10) International Publication Number
WO 2004/010039 A3

(51) International Patent Classification[7]: E21B 19/16, 7/00, 29/10, F16L 21/00

(21) International Application Number: PCT/US2003/019993

(22) International Filing Date: 24 June 2003 (24.06.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/397,284 19 July 2002 (19.07.2002) US

(71) Applicant (*for all designated States except US*): **ENVENTURE GLOBAL TECHNOLOGY** [US/US]; 16200 A Park Row, Houston, TX 77084 (US).

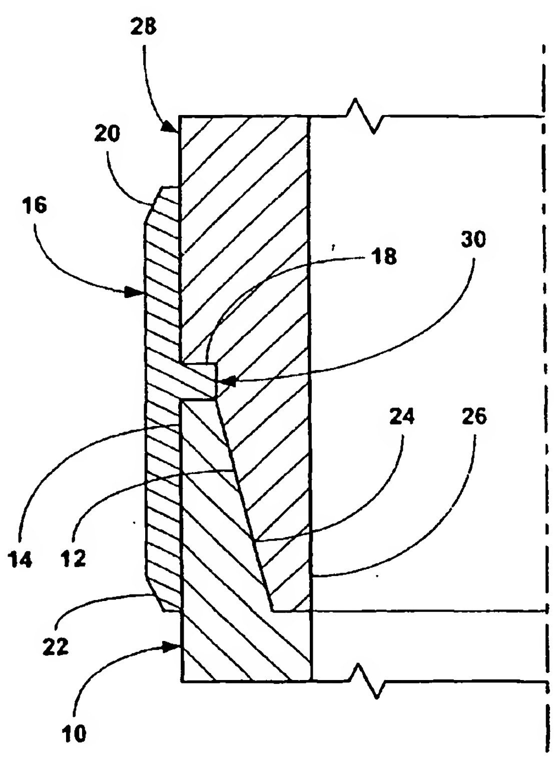
(72) Inventors; and
(75) Inventors/Applicants (*for US only*): **COSTA, Scott** [US/US]; 2011 Willow Point, Kingwood, TX 77339 (US). **HOCKADAY, Joel** [US/US]; 17318 Ginger Fields Lane, Tomball, TX 77375 (US). **WADDELL, Kevin, K.** [US/US]; 11007 Sprucedale Court, Houston, TX 77070 (US). **RING, Lev** [RU/US]; 14126 Heatherhill Place, Houston, TX 77077 (US). **BULLOCK, Michael** [US/US]; 19827 Sky Country, Houston, TX 77094 (US). **COOK, Robert, Lance** [US/US]; 934 Caswell Court, Katy, TX 77450 (US). **KENDZIORA, Larry** [US/US]; 6518 Williams School Court, Needville, TX 77461 (US). **BRISCO, David, Paul** [US/US]; 405 Westridge Drive, Duncan, OK 73533 (US). **JACKSON, Tance** [US/US]; 7209 Ridgemoor Lane, Plano, TX 75025 (US). **RAO, Vikram** [US/US]; 6429 Edloe, Houston, TX 77005 (US).

(74) Agents: **MATTINGLY, Todd** et al.; Haynes and Boone, LLP, 901 Main Street, Suite 3100, Dallas, TX 75202-3789 (US).

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU,

[Continued on next page]

(54) Title: PROTECTIVE SLEEVE FOR THREADED CONNECTIONS FOR EXPANDABLE LINER HANGER



(57) Abstract: A tubular sleeve (16) is coupled to and overlaps the threaded connection between a pair of adjacent tubular members (10 and 28). The adjacent tubular members (10 and 28) are then radially expanded and plastically deformed.

WO 2004/010039 A3

CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) **Designated States** (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declaration under Rule 4.17:
— *of inventorship (Rule 4.17(iv)) for US only*

Published:
— *with international search report*
— *with amended claims*

(88) **Date of publication of the international search report:** 8 July 2004

Date of publication of the amended claims: 27 January 2005

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

AMENDED CLAIMS
[received by the International Bureau on 20 July 2004 (20.07.2004);
original claims 1-166 replaced by new claims 1-253 (32 pages)]

Claims

What is claimed is:

1. A method, comprising:
coupling an end of a first tubular member to an end of a tubular sleeve;
coupling an end of a second tubular member to another end of the tubular sleeve;
coupling the ends of the first and second tubular members; and
radially expanding and plastically deforming the first tubular member and the second tubular member.

2. The method of claim 1, wherein the tubular sleeve comprises an internal flange.

3. The method of claim 2, wherein coupling the end of the first tubular member to the end of the tubular sleeve comprises:
inserting the end of the first tubular member into the end of the tubular sleeve into abutment with the internal flange.

4. The method of claim 3, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:
inserting the end of the second tubular member into the other end of the tubular sleeve into abutment with the internal flange.

5. The method of claim 2, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:
inserting the end of the second tubular member into the other end of the tubular sleeve into abutment with the internal flange.

6. The method of claim 1, wherein the tubular sleeve comprises an external flange.

7. The method of claim 6, wherein coupling the end of the first tubular member to the end of the tubular sleeve comprises:
inserting the end of the tubular sleeve into the end of the first tubular member until the end of the first tubular member abuts the external flange.

8. The method of claim 7, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:
inserting the other end of the tubular sleeve into the end of the second tubular member until the end of the second tubular member abuts the external flange.

9. The method of claim 6, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:
inserting the other end of the tubular sleeve into the end of the second tubular member until the end of the second tubular member abuts the external flange.

10. The method of claim 1, wherein coupling the end of the first tubular member to the end of the tubular sleeve comprises:

inserting a retaining ring between the end of the first tubular member and the end of the tubular sleeve.

11. The method of claim 10, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

inserting another retaining ring between the end of the second tubular member and the other end of the tubular sleeve.

12. The method of claim 1, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

inserting a retaining ring between the end of the first tubular member and the other end of the tubular sleeve.

13. The method of claim 10, wherein the retaining ring is resilient.

14. The method of claim 11, wherein the retaining ring and the other retaining ring are resilient.

15. The method of claim 12, wherein the retaining ring is resilient.

16. The method of claim 1, wherein coupling the end of the first tubular member to the end of the tubular sleeve comprises:

deforming the end of the tubular sleeve.

17. The method of claim 16, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

deforming the other end of the tubular sleeve.

18. The method of claim 1, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

deforming the other end of the tubular sleeve.

19. The method of claim 1, wherein coupling the end of the first tubular member to the end of the tubular sleeve comprises:

coupling a retaining ring to the end of the first tubular member.

20. The method of claim 19, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

coupling another retaining ring to the end of the second tubular member.

21. The method of claim 1, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

coupling a retaining ring to the end of the second tubular member.

22. The method of claim 19, wherein the retaining ring is resilient.

23. The method of claim 20, wherein the retaining ring and the other retaining ring are resilient.

24. The method of claim 21, wherein the retaining ring is resilient.

25. The method of claim 1, wherein coupling the end of the first tubular member to the

end of the tubular sleeve comprises:

heating the end of the tubular sleeve; and

inserting the end of the first tubular member into the end of the tubular sleeve.

26. The method of claim 25, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

heating the other end of the tubular sleeve; and

inserting the end of the second tubular member into the other end of the tubular sleeve.

27. The method of claim 1, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

heating the other end of the tubular sleeve; and

inserting the end of the second tubular member into the other end of the tubular sleeve.

28. The method of claim 1, wherein coupling the end of the first tubular member to the end of the tubular sleeve comprises:

inserting the end of the first tubular member into the end of the tubular sleeve; and

latching the end of the first tubular member to the end of the tubular sleeve.

29. The method of claim 28, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

inserting the end of the second tubular member into the end of the tubular sleeve; and

latching the end of the second tubular member to the other end of the tubular sleeve.

30. The method of claim 1, wherein coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

inserting the end of the second tubular member into the end of the tubular sleeve; and

latching the end of the second tubular member to the other end of the tubular sleeve.

31. The method of claim 1, wherein the tubular sleeve further comprises one or more sealing members for sealing the interface between the tubular sleeve and at least one of the tubular members.

32. The method of claim 1, further comprising:

placing the tubular members in another structure; and

then radially expanding and plastically deforming the first tubular member and the second tubular member.

33. The method of claim 32, further comprising:

radially expanding the tubular sleeve into engagement with the structure.

34. The method of claim 32, further comprising:

sealing an annulus between the tubular sleeve and the other structure.

35. The method of claim 32, wherein the other structure comprises a wellbore.

36. The method of claim 32, wherein the other structure comprises a wellbore casing.

37. The method of claim 1, wherein the tubular sleeve further comprises a sealing element coupled to the exterior of the tubular sleeve.

38. The method of claim 1, wherein the tubular sleeve is metallic.

39. The method of claim 1, wherein the tubular sleeve is non-metallic.

40. The method of claim 1, wherein the tubular sleeve is plastic.

41. The method of claim 1, wherein the tubular sleeve is ceramic.

42. The method of claim 1, further comprising:

breaking the tubular sleeve.

43. The method of claim 1, wherein the tubular sleeve includes one or more longitudinal slots.

44. The method of claim 1, wherein the tubular sleeve includes one or more radial passages.

45. The method of claim 1, wherein radially expanding and plastically deforming the first tubular member, the second tubular member, and the tubular sleeve comprises:

displacing an expansion cone within and relative to the first and second tubular members.

46. The method of claim 1, wherein radially expanding and plastically deforming the first tubular member, the second tubular member, and the tubular sleeve comprises:

applying radial pressure to the interior surfaces of the first and second tubular member using a rotating member.

47. The method of claim 1, further comprising:

amorphously bonding the first and second tubular members during the radial expansion and plastic deformation of the first and second tubular members.

48. The method of claim 1, further comprising:

welding the first and second tubular members during the radial expansion and plastic deformation of the first and second tubular members.

49. The method of claim 1, further comprising:

providing a fluid tight seal within the threaded coupling between the first and second tubular members during the radial expansion and plastic deformation of the first and second tubular members.

50. The method of claim 1, further comprising:

placing the tubular sleeve in circumferential tension;

placing the end of the first tubular member in circumferential compression; and

placing the end of the second tubular member in circumferential compression.

51. The method of claim 1, further comprising:

placing the tubular sleeve in circumferential compression;

placing the end of the first tubular member in circumferential tension; and

placing the end of the second tubular member in circumferential tension.

52. The method of claim 1, wherein radially expanding and plastically deforming the first tubular member and the second tubular member comprises:

radially expanding and plastically deforming only the portions of the first and second members proximate the tubular sleeve.

53. The method of claim 52, further comprising:

providing a fluid tight seal between the tubular sleeve and at least one of the first and second tubular members.

54. The method of claim 1, wherein the first tubular member comprises internal threads; and wherein the second tubular member comprises external threads that engage the internal threads of the first tubular member.

55. The method of claim 54, wherein radially expanding and plastically deforming the first tubular member and the second tubular member comprises:

radially expanding and plastically deforming only the portions of the first and second members proximate the threads of the first and second tubular members.

56. The method of claim 55, further comprising:

providing a fluid tight seal between the threads of the first and second tubular members.

57. The method of claim 55, further comprising:

providing a fluid tight seal between the tubular sleeve and at least one of the first and second tubular members.

58. The method of claim 1, wherein the first and second tubular members comprise wellbore casings.

59. The method of claim 1, wherein the first and second tubular members comprise pipes.

60. A method, comprising:

providing a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve;

inserting an end of a first tubular member into an end of the tubular sleeve into abutment with the internal flange;

inserting an end of a second tubular member into another end of the tubular sleeve into abutment the internal flange;

threadably coupling the ends of the first and second tubular members;.

radially expanding and plastically deforming the first tubular member and the second

tubular member;

placing the tubular sleeve in circumferential tension;

placing the end of the first tubular member in circumferential compression; and

placing the end of the second tubular member in circumferential compression.

61. A method, comprising:

providing a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;

inserting an end of the tubular sleeve into an end of a first tubular member until the end of the first tubular member abuts with the external flange;

inserting another end of the tubular sleeve into an end of the second tubular member until the end of the second tubular member abuts the external flange;

threadably coupling the ends of the first and second tubular members;

radially expanding and plastically deforming the first tubular member and the second tubular member;

placing the tubular sleeve in circumferential compression;

placing the end of the first tubular member in circumferential tension; and

placing the end of the second tubular member in circumferential tension.

62. A method, comprising:

providing a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve;

inserting an end of a first tubular member into an end of the tubular sleeve into abutment with the internal flange;

inserting an end of a second tubular member into another end of the tubular sleeve into abutment the internal flange;

threadably coupling the ends of the first and second tubular members;

radially expanding and plastically deforming only the portions of the first tubular member and the second tubular member proximate the threads of the first and second tubular members;

placing the tubular sleeve in circumferential tension;

placing the end of the first tubular member in circumferential compression; and

placing the end of the second tubular member in circumferential compression.

63. A method, comprising:

providing a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;

inserting an end of the tubular sleeve into an end of a first tubular member until the end of the first tubular member abuts with the external flange;

inserting another end of the tubular sleeve into an end of the second tubular member

until the end of the second tubular member abuts the external flange;

threadably coupling the ends of the first and second tubular members;

radially expanding and plastically deforming only the portions of the first tubular member and the second tubular member proximate the threads of the first and second tubular members;

placing the tubular sleeve in circumferential compression;

placing the end of the first tubular member in circumferential tension; and

placing the end of the second tubular member in circumferential tension.

64. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve; and

a second tubular member coupled to another end of the tubular sleeve and the first tubular member;

wherein the tubular sleeve is stressed in a first direction;

wherein the end portions of at least one of the first and second tubular members are stressed in a second direction; and

wherein the first direction is different from the second direction.

65. The apparatus of claim 64,

wherein the tubular sleeve is in circumferential tension;

wherein the end portion of the first tubular member is in circumferential compression; and

wherein the end portion of the second tubular member is in circumferential compression.

66. The apparatus of claim 64,

wherein the tubular sleeve is in circumferential compression;

wherein the end portion of the first tubular member is in circumferential tension; and

wherein the end portion of the second tubular member is in circumferential tension.

67. The apparatus of claim 64, wherein the tubular sleeve comprises an internal flange.

68. The apparatus of claim 67, wherein the end portion of the first tubular member is received within an end of the tubular sleeve; and wherein the end portion of the second tubular member is received within another end of the tubular sleeve.

69. The apparatus of claim 68, wherein the end portions of the first and second tubular members abut the internal flange of the tubular sleeve.

70. The apparatus of claim 67, wherein the end portion of the first tubular member is received within an end of the tubular sleeve.

71. The apparatus of claim 70, wherein the end portions of the first and second tubular members abut the internal flange of the tubular sleeve.

72. The apparatus of claim 67, wherein the end portion of the second tubular member is received within an end of the tubular sleeve.

73. The apparatus of claim 72, wherein the end portions of the first and second tubular members abut the internal flange of the tubular sleeve.

74. The apparatus of claim 67, wherein the internal flange of the tubular sleeve is positioned between the ends of the tubular sleeve.

75. The apparatus of claim 67, wherein the internal flange of the tubular sleeve is positioned at an end of the tubular sleeve.

76. The apparatus of claim 64, wherein the tubular sleeve comprises an external flange.

77. The apparatus of claim 76, wherein an end portion of the tubular sleeve is received within the first tubular member; and wherein another end portion of the tubular sleeve is received within the end portion of the second tubular member.

78. The apparatus of claim 77, wherein the end portions of the first and second tubular members abut the external flange of the tubular sleeve.

79. The apparatus of claim 76, wherein an end portion of the tubular sleeve is received within the end portion of the first tubular member.

80. The apparatus of claim 79, wherein the end portions of the first and second tubular members abut the external flange of the tubular sleeve.

81. The apparatus of claim 76, wherein an end portion of the tubular sleeve is received within the end portion of the second tubular member.

82. The apparatus of claim 81, wherein the end portions of the first and second tubular members abut the external flange of the tubular sleeve.

83. The apparatus of claim 76, wherein the external flange of the tubular sleeve is positioned between the ends of the tubular sleeve.

84. The apparatus of claim 76, wherein the external flange of the tubular sleeve is positioned at an end of the tubular sleeve.

85. The apparatus of claim 64, wherein the tubular sleeve further comprises one or more sealing members for sealing the interface between the tubular sleeve and at least one of the tubular members.

86. The apparatus of claim 64, further comprising:

a retaining ring positioned between the end of the first tubular member and the end of the tubular sleeve.

87. The apparatus of claim 86, further comprising:

another retaining ring positioned between the end of the second tubular member and the other end of the tubular sleeve.

88. The apparatus of claim 64, further comprising:

a retaining ring positioned between the end of the first tubular member and the other

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end of the tubular sleeve.

89. The apparatus of claim 86, wherein the retaining ring is resilient.

90. The apparatus of claim 87, wherein the retaining ring and the other retaining ring are resilient.

91. The apparatus of claim 88, wherein the retaining ring is resilient.

92. The apparatus of claim 64, wherein the end of the tubular sleeve is deformed onto the end of the first tubular member.

93. The apparatus of claim 92, wherein the other end of the tubular sleeve is deformed onto the end of the second tubular member.

94. The apparatus of claim 64, wherein the other end of the tubular sleeve is deformed onto the end of the second tubular member.

95. The apparatus of claim 64, further comprising:

a retaining ring coupled to the end of the first tubular member for retaining the tubular sleeve onto the end of the first tubular member.

96. The apparatus of claim 95, further comprising:

another retaining ring coupled to the end of the second tubular member for retaining the other end of the tubular sleeve onto the end of the second tubular member.

97. The apparatus of claim 64, further comprising:

a retaining ring coupled to the end of the second tubular member for retaining the other end of the tubular sleeve onto the end of the second tubular member.

98. The apparatus of claim 95, wherein the retaining ring is resilient.

99. The apparatus of claim 96, wherein the retaining ring and the other retaining ring are resilient.

100. The apparatus of claim 97, wherein the retaining ring is resilient.

101. The apparatus of claim 64, further comprising:

a locking ring for coupling the end of the first tubular member to the end of the tubular sleeve.

102. The apparatus of claim 101, further comprising:

another locking ring for coupling the end of the second tubular member to the other end of the tubular sleeve.

103. The apparatus of claim 64, further comprising:

a locking ring for coupling the end of the second tubular member to the other end of the tubular sleeve.

104. The apparatus of claim 64, further comprising:

a structure for receiving the first and second tubular members and the tubular sleeve;

wherein the tubular sleeve contacts the interior surface of the structure.

105. The apparatus of claim 104, wherein the tubular sleeve further comprises:
a sealing member for fluidicly sealing the interface between the tubular sleeve and the structure.

106. The apparatus of claim 104, wherein the other structure comprises a wellbore.

107. The apparatus of claim 104, wherein the other structure comprises a wellbore casing.

108. The apparatus of claim 64, wherein the tubular sleeve further comprises a sealing element coupled to the exterior surface of the tubular sleeve.

109. The apparatus of claim 64, wherein the tubular sleeve is metallic.

110. The apparatus of claim 64, wherein the tubular sleeve is non-metallic.

111. The apparatus of claim 64, wherein the tubular sleeve is plastic.

112. The apparatus of claim 64, wherein the tubular sleeve is ceramic.

113. The apparatus of claim 64, wherein the tubular sleeve is frangible.

114. The apparatus of claim 64, wherein the tubular sleeve comprises one or more longitudinal slots.

115. The apparatus of claim 64, wherein the tubular sleeve comprises one or more radial passages.

116. The apparatus of claim 64, wherein the first and second tubular members are amorphously bonded.

117. The apparatus of claim 64, wherein the first and second tubular members are welded.

118. The apparatus of claim 64, wherein only the portions of the first and second tubular members proximate the tubular sleeve are plastically deformed.

119. The apparatus of claim 118, wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members.

120. The apparatus of claim 64, wherein the first tubular member comprises internal threads; and wherein the second tubular member comprises external threads that engage the internal threads of the first tubular member.

121. The apparatus of claim 120, wherein only the portions of the first and second members proximate the threads of the first and second tubular members are plastically deformed.

122. The apparatus of claim 121, wherein a fluid tight seal is provided between the threads of the first and second tubular members.

123. The apparatus of claim 121, wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members.

124. An apparatus, comprising:
a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve;
a first tubular member received within an end of the tubular sleeve in abutment with

the internal flange that comprises internal threads; and
a second tubular member received within another end of the tubular sleeve in abutment with the internal flange that comprises external threads that engage the internal threads of the first tubular member;
wherein the tubular sleeve is in circumferential tension;
wherein the end of first tubular member is in circumferential compression; and
wherein the end of the second tubular member is in circumferential compression.

125. An apparatus, comprising:
a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;
a first tubular member that receives an end of the tubular sleeve and abuts the external flange that comprises internal threads; and
a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first tubular member;
wherein the tubular sleeve is in circumferential compression;
wherein the first tubular member is in circumferential tension; and
wherein the second tubular member is in circumferential tension.

126. An apparatus, comprising:
a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve;
a first tubular member received within an end of the tubular sleeve in abutment with the internal flange that comprises internal threads; and
a second tubular member received within another end of the tubular sleeve in abutment with the internal flange that comprises external threads that engage the internal threads of the first tubular member;
wherein the tubular sleeve is in circumferential tension;
wherein the end of first tubular member is in circumferential compression;
wherein the end of the second tubular member is in circumferential compression;
wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members; and
wherein a fluid tight seal is provided between the threads of the first and second tubular members.

127. An apparatus, comprising:
a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;
a first tubular member that receives an end of the tubular sleeve and abuts the

external flange that comprises internal threads; and

a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first tubular member;

wherein the tubular sleeve is in circumferential compression;

wherein the first tubular member is in circumferential tension;

wherein the second tubular member is in circumferential tension;

wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members; and

wherein a fluid tight seal is provided between the threads of the first and second tubular members.

128. A method of extracting geothermal energy from a subterranean source of geothermal energy, comprising:

drilling a borehole that traverses the subterranean source of geothermal energy;

positioning a first casing string within the borehole;

radially expanding and plastically deforming the first casing string within the borehole;

positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy;

overlapping a portion of the second casing string with a portion of the first casing string;

radially expanding and plastically deforming the second casing string within the borehole; and

extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings.

129. The method of claim 128, wherein the interior diameter of a passage defined by the first and second casing strings is constant.

130. The method of claim 128, wherein at least one of the first and second casing strings comprise:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member.

131. A method of extracting geothermal energy from a subterranean source of geothermal energy, comprising:

drilling a borehole that traverses the subterranean source of geothermal energy;

positioning a first casing string within the borehole;
radially expanding and plastically deforming the first casing string within the borehole;
positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy;
overlapping a portion of the second casing string with a portion of the first casing string;
radially expanding and plastically deforming the second casing string within the borehole; and
extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings;
wherein the interior diameter of a passage defined by the first and second casing strings is constant; and
wherein at least one of the first and second casing strings comprise:
a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve;
a first tubular member received within an end of the tubular sleeve in abutment with the internal flange that comprises internal threads; and
a second tubular member received within another end of the tubular sleeve in abutment with the internal flange that comprises external threads that engage the internal threads of the first tubular member.

132. A method of extracting geothermal energy from a subterranean source of geothermal energy, comprising:
drilling a borehole that traverses the subterranean source of geothermal energy;
positioning a first casing string within the borehole;
radially expanding and plastically deforming the first casing string within the borehole;
positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy;
overlapping a portion of the second casing string with a portion of the first casing string;
radially expanding and plastically deforming the second casing string within the borehole; and
extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings;
wherein the interior diameter of a passage defined by the first and second casing strings is constant; and
wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;

a first tubular member that receives an end of the tubular sleeve that abuts external flange that comprises internal threads; and

a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first tubular member.

133. A method of extracting geothermal energy from a subterranean source of geothermal energy, comprising:

drilling a borehole that traverses the subterranean source of geothermal energy;

positioning a first casing string within the borehole;

radially expanding and plastically deforming the first casing string within the borehole;

positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy;

overlapping a portion of the second casing string with a portion of the first casing string;

radially expanding and plastically deforming the second casing string within the borehole; and

extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings;

wherein the interior diameter of a passage defined by the first and second casing strings is constant; and

wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve;

a first tubular member received within an end of the tubular sleeve in abutment with the internal flange that comprises internal threads; and

a second tubular member received within another end of the tubular sleeve in abutment with the internal flange that comprises external threads that engage the internal threads of the first tubular member;

wherein the tubular sleeve is in circumferential tension;

wherein the first tubular member is in circumferential compression;

wherein the second tubular member is in circumferential compression;

wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members; and

wherein a fluid tight seal is provided between the threads of the first and second tubular members.

134. A method of extracting geothermal energy from a subterranean source of geothermal energy, comprising:

drilling a borehole that traverses the subterranean source of geothermal energy;

positioning a first casing string within the borehole;

radially expanding and plastically deforming the first casing string within the borehole;

positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy;

overlapping a portion of the second casing string with a portion of the first casing string;

radially expanding and plastically deforming the second casing string within the borehole; and

extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings;

wherein the interior diameter of a passage defined by the first and second casing strings is constant; and

wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;

a first tubular member that receives an end of the tubular sleeve that abuts external flange that comprises internal threads; and

a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first tubular member;

wherein the tubular sleeve is in circumferential compression;

wherein the first tubular member is in circumferential tension;

wherein the second tubular member is in circumferential tension;

wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members; and

wherein a fluid tight seal is provided between the threads of the first and second tubular members.

135. An apparatus for extracting geothermal energy from a subterranean source of geothermal energy, comprising:

a borehole that traverses the subterranean source of geothermal energy;

a first casing string positioned within the borehole; and

a second casing positioned within the borehole that overlaps with the first casing string that traverses the subterranean source of geothermal energy;

wherein the first casing string and the second casing string are radially expanded and

plastically deformed within the borehole.

136. The apparatus of claim 135, wherein the interior diameter of a passage defined by the first and second casing strings is constant.

137. The apparatus of claim 135, wherein at least one of the first and second casing strings comprise:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member.

138. An apparatus for extracting geothermal energy from a subterranean source of geothermal energy, comprising:

a borehole that traverses the subterranean source of geothermal energy;

a first casing string positioned within the borehole;

a second casing string within the borehole that traverses the subterranean source of geothermal energy that overlaps with the first casing string;

wherein the first and second casing strings are radially expanded and plastically deformed within the borehole;

wherein the inside diameter of a passage defined by the first and second casing strings is constant; and

wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve;

a first tubular member received within an end of the tubular sleeve in abutment with the internal flange that comprises internal threads; and

a second tubular member received within another end of the tubular sleeve in abutment with the internal flange that comprises external threads that engage the internal threads of the first tubular member.

139. An apparatus for extracting geothermal energy from a subterranean source of geothermal energy, comprising:

a borehole that traverses the subterranean source of geothermal energy;

a first casing string positioned within the borehole; and

a second casing string positioned within the borehole that traverses the subterranean source of geothermal energy that overlaps with the first casing string;

wherein the interior diameter of a passage defined by the first and second casing strings is constant; and

wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;

a first tubular member that receives an end of the tubular sleeve that abuts external flange that comprises internal threads; and

a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first tubular member.

140. An apparatus for extracting geothermal energy from a subterranean source of geothermal energy, comprising:

a borehole that traverses the subterranean source of geothermal energy;

a first casing string positioned within the borehole;

a second casing string within the borehole that traverses the subterranean source of geothermal energy that overlaps with the first casing string;

wherein the first and second casing strings are radially expanded and plastically deformed within the borehole;

wherein the inside diameter of a passage defined by the first and second casing strings is constant; and

wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve;

a first tubular member received within an end of the tubular sleeve in abutment with the internal flange that comprises internal threads;

a second tubular member received within another end of the tubular sleeve in abutment with the internal flange that comprises external threads that engage the internal threads of the first tubular member;

wherein the tubular sleeve is in circumferential tension;

wherein the first tubular member is in circumferential compression;

wherein the second tubular member is in circumferential compression;

wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members; and

wherein a fluid tight seal is provided between the threads of the first and second tubular members.

141. An apparatus for extracting geothermal energy from a subterranean source of geothermal energy, comprising:

a borehole that traverses the subterranean source of geothermal energy;

a first casing string positioned within the borehole; and

a second casing string positioned within the borehole that traverses the subterranean source of geothermal energy that overlaps with the first casing string;

wherein the interior diameter of a passage defined by the first and second casing strings is constant; and

wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;

a first tubular member that receives an end of the tubular sleeve that abuts external flange that comprises internal threads;

a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first tubular member;

wherein the tubular sleeve is in circumferential compression;

wherein the first tubular member is in circumferential tension;

wherein the second tubular member is in circumferential tension;

wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members; and

wherein a fluid tight seal is provided between the threads of the first and second tubular members.

142. A method, comprising:

coupling the ends of first and second tubular members;

injecting a pressurized fluid through the first and second tubular members;

determining if any of the pressurized fluid leaks through the coupled ends of the first and second tubular members; and

if a predetermined amount of the pressurized fluid leaks through the coupled ends of the first and second tubular members, then coupling a tubular sleeve to the ends of the first and second tubular members and radially expanding and plastically deforming only the portions of the first and second tubular members proximate the tubular sleeve.

143. The method of claim 142, wherein radially expanding and plastically deforming only the portions of the first and second tubular members proximate the tubular sleeve comprises:

displacing an expansion cone within and relative to the first and second tubular members.

144. The method of claim 142, wherein radially expanding and plastically deforming only the portions of the first and second tubular members proximate the tubular sleeve comprises:

applying radial pressure to the interior surfaces of the first and second tubular member proximate the tubular sleeve using a rotating member.

145. The method of claim 1, further comprising:
transmitting energy through the first and second tubular members.

146. The method of claim 145, wherein the energy comprises electrical energy.

147. The method of claim 146, wherein the electrical energy comprises a communication signal.

148. The method of claim 145, wherein the energy comprises thermal energy.

149. The method of claim 145, wherein the energy comprises acoustic energy.

150. The method of claim 145, wherein the energy is transmitted through the first and second tubular members prior to radially expanding and plastically deforming the first and second tubular members.

151. The method of claim 145, wherein the energy is transmitted through the first and second tubular members after radially expanding and plastically deforming the first and second tubular members.

152. The method of claim 32, further comprising:
transmitting energy through the first and second tubular members.

153. The method of claim 152, wherein the energy comprises electrical energy.

154. The method of claim 153, wherein the electrical energy comprises a communication signal.

155. The method of claim 152, wherein the energy comprises thermal energy.

156. The method of claim 152, wherein the energy comprises acoustic energy.

157. The method of claim 152, wherein the energy is transmitted through the first and second tubular members prior to radially expanding and plastically deforming the first and second tubular members.

158. The method of claim 152, wherein the energy is transmitted through the first and second tubular members after radially expanding and plastically deforming the first and second tubular members.

159. A system comprising:
a source of energy;
a borehole formed in the earth;
a first tubular member positioned within the borehole operably coupled to the source of energy;
a second tubular member positioned within the borehole coupled to the first tubular member; and
a tubular sleeve positioned within the borehole coupled to the first and second tubular members;
wherein the first tubular member, second tubular member, and the tubular sleeve are plastically deformed into engagement with one another.

160. The system of claim 159, wherein the source of energy comprises a source of electrical energy.

161. The system of claim 159, wherein the source of energy comprises a source of thermal energy.

162. The system of claim 159, wherein the source of energy comprises a source of acoustic energy.

163. A method of operating a well for extracting hydrocarbons from a subterranean formation, comprising:

drilling a borehole into the earth that traverses the subterranean formation;
positioning a wellbore casing in the borehole;
transmitting energy through the wellbore casing; and
extracting hydrocarbons from the subterranean formation;
wherein the wellbore casing comprises:
a first tubular member;
a second tubular member coupled to the first tubular member; and
a tubular sleeve coupled to the first and second tubular member; and
wherein the first tubular member, the second tubular member, and the tubular sleeve are plastically deformed into engagement with one another.

164. The method of claim 163, wherein the energy comprises electrical energy.

165. The system of claim 163, wherein the energy comprises thermal energy.

166. The system of claim 163, wherein the energy comprises acoustic energy.

167. A system, comprising:

means for coupling an end of a first tubular member to an end of a tubular sleeve;
means for coupling an end of a second tubular member to another end of the tubular sleeve;
means for coupling the ends of the first and second tubular members; and
means for radially expanding and plastically deforming the first tubular member and the second tubular member.

168. The system of claim 167, wherein the tubular sleeve comprises an internal flange.

169. The system of claim 168, wherein means for coupling the end of the first tubular member to the end of the tubular sleeve comprises:

means for inserting the end of the first tubular member into the end of the tubular sleeve into abutment with the internal flange.

170. The system of claim 169, wherein means for coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

means for inserting the end of the second tubular member into the other end of the tubular sleeve into abutment with the internal flange.

171. The system of claim 168, wherein means for coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

means for inserting the end of the second tubular member into the other end of the tubular sleeve into abutment with the internal flange.

172. The system of claim 167, wherein the tubular sleeve comprises an external flange.

173. The system of claim 172, wherein means for coupling the end of the first tubular member to the end of the tubular sleeve comprises:

means for inserting the end of the tubular sleeve into the end of the first tubular member until the end of the first tubular member abuts the external flange.

174. The system of claim 173, wherein means for coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

means for inserting the other end of the tubular sleeve into the end of the second tubular member until the end of the second tubular member abuts the external flange.

175. The system of claim 172, wherein means for coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

means for inserting the other end of the tubular sleeve into the end of the second tubular member until the end of the second tubular member abuts the external flange.

176. The system of claim 167, wherein means for coupling the end of the first tubular member to the end of the tubular sleeve comprises:

means for inserting a retaining ring between the end of the first tubular member and the end of the tubular sleeve.

177. The system of claim 176, wherein means for coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

means for inserting another retaining ring between the end of the second tubular member and the other end of the tubular sleeve.

178. The system of claim 167, wherein means for coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

means for inserting a retaining ring between the end of the first tubular member and the other end of the tubular sleeve.

179. The system of claim 176, wherein the retaining ring is resilient.

180. The system of claim 177, wherein the retaining ring and the other retaining ring are resilient.

181. The system of claim 178, wherein the retaining ring is resilient.

182. The system of claim 167, wherein means for coupling the end of the first tubular member to the end of the tubular sleeve comprises:

means for deforming the end of the tubular sleeve.

183. The system of claim 182, wherein means for coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

means for deforming the other end of the tubular sleeve.

184. The system of claim 167, wherein means for coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

means for deforming the other end of the tubular sleeve.

185. The system of claim 167, wherein means for coupling the end of the first tubular member to the end of the tubular sleeve comprises:

means for coupling a retaining ring to the end of the first tubular member.

186. The system of claim 185, wherein means for coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

means for coupling another retaining ring to the end of the second tubular member.

187. The system of claim 167, wherein means for coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

means for coupling a retaining ring to the end of the second tubular member.

188. The system of claim 185, wherein the retaining ring is resilient.

189. The system of claim 186, wherein the retaining ring and the other retaining ring are resilient.

190. The system of claim 187, wherein the retaining ring is resilient.

191. The system of claim 167, wherein means for coupling the end of the first tubular member to the end of the tubular sleeve comprises:

means for heating the end of the tubular sleeve; and

means for inserting the end of the first tubular member into the end of the tubular sleeve.

192. The system of claim 191, wherein means for coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

means for heating the other end of the tubular sleeve; and

means for inserting the end of the second tubular member into the other end of the tubular sleeve.

193. The system of claim 167, wherein means for coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

means for heating the other end of the tubular sleeve; and

means for inserting the end of the second tubular member into the other end of the tubular sleeve.

194. The system of claim 167, wherein means for coupling the end of the first tubular member to the end of the tubular sleeve comprises:

means for inserting the end of the first tubular member into the end of the tubular sleeve; and

means for latching the end of the first tubular member to the end of the tubular sleeve.

195. The system of claim 194, wherein means for coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

means for inserting the end of the second tubular member into the end of the tubular sleeve; and

means for latching the end of the second tubular member to the other end of the tubular sleeve.

196. The system of claim 167, wherein means for coupling the end of the second tubular member to the other end of the tubular sleeve comprises:

means for inserting the end of the second tubular member into the end of the tubular sleeve; and

means for latching the end of the second tubular member to the other end of the tubular sleeve.

197. The system of claim 167, wherein the tubular sleeve further comprises one or more sealing members for sealing the interface between the tubular sleeve and at least one of the tubular members.

198. The system of claim 167, further comprising:

means for placing the tubular members in another structure; and

means for then radially expanding and plastically deforming the first tubular member and the second tubular member.

199. The system of claim 198, further comprising:

means for radially expanding the tubular sleeve into engagement with the structure.

200. The system of claim 198, further comprising:

means for sealing an annulus between the tubular sleeve and the other structure.

201. The system of claim 198, wherein the other structure comprises a wellbore.

202. The system of claim 198, wherein the other structure comprises a wellbore casing.

203. The system of claim 167, wherein the tubular sleeve further comprises a sealing element coupled to the exterior of the tubular sleeve.

204. The system of claim 167, wherein the tubular sleeve is metallic.

205. The system of claim 167, wherein the tubular sleeve is non-metallic.

206. The system of claim 167, wherein the tubular sleeve is plastic.

207. The system of claim 167, wherein the tubular sleeve is ceramic.

208. The system of claim 167, further comprising:

means for breaking the tubular sleeve.

209. The system of claim 167, wherein the tubular sleeve includes one or more longitudinal slots.

210. The system of claim 167, wherein the tubular sleeve includes one or more radial passages.

211. The system of claim 167, wherein means for radially expanding and plastically deforming the first tubular member, the second tubular member, and the tubular sleeve comprises:

means for displacing an expansion cone within and relative to the first and second tubular members.

212. The system of claim 167, wherein means for radially expanding and plastically deforming the first tubular member, the second tubular member, and the tubular sleeve comprises:

means for applying radial pressure to the interior surfaces of the first and second tubular member using a rotating member.

213. The system of claim 167, further comprising:

means for amorphously bonding the first and second tubular members during the radial expansion and plastic deformation of the first and second tubular members.

214. The system of claim 167, further comprising:

means for welding the first and second tubular members during the radial expansion and plastic deformation of the first and second tubular members.

215. The system of claim 167, further comprising:

means for providing a fluid tight seal within the threaded coupling between the first and second tubular members during the radial expansion and plastic deformation of the first and second tubular members.

216. The system of claim 167, further comprising:

means for placing the tubular sleeve in circumferential tension;

means for placing the end of the first tubular member in circumferential compression; and

means for placing the end of the second tubular member in circumferential compression.

217. The system of claim 167, further comprising:

means for placing the tubular sleeve in circumferential compression;

means for placing the end of the first tubular member in circumferential tension; and

means for placing the end of the second tubular member in circumferential tension.

218. The system of claim 167, wherein radially expanding and plastically deforming the first tubular member and the second tubular member comprises:

means for radially expanding and plastically deforming only the portions of the first and second members proximate the tubular sleeve.

219. The system of claim 218, further comprising:

means for providing a fluid tight seal between the tubular sleeve and at least one of the first and second tubular members.

220. The system of claim 167, wherein the first tubular member comprises internal threads; and wherein the second tubular member comprises external threads that engage the internal threads of the first tubular member.

221. The system of claim 220, wherein means for radially expanding and plastically deforming the first tubular member and the second tubular member comprises:

means for radially expanding and plastically deforming only the portions of the first and second members proximate the threads of the first and second tubular members.

222. The system of claim 221, further comprising:

means for providing a fluid tight seal between the threads of the first and second tubular members.

223. The system of claim 221, further comprising:

means for providing a fluid tight seal between the tubular sleeve and at least one of the first and second tubular members.

224. The system of claim 167, wherein the first and second tubular members comprise wellbore casings.

225. The system of claim 167, wherein the first and second tubular members comprise pipes.

226. A system, comprising:

means for providing a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve;

means for inserting an end of a first tubular member into an end of the tubular sleeve into abutment with the internal flange;

means for inserting an end of a second tubular member into another end of the tubular sleeve into abutment the internal flange;

means for threadably coupling the ends of the first and second tubular members;

means for radially expanding and plastically deforming the first tubular member and the second tubular member;

means for placing the tubular sleeve in circumferential tension;

means for placing the end of the first tubular member in circumferential compression; and

means for placing the end of the second tubular member in circumferential

compression.

227. A system, comprising:

means for providing a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;

means for inserting an end of the tubular sleeve into an end of a first tubular member until the end of the first tubular member abuts with the external flange;

means for inserting another end of the tubular sleeve into an end of the second tubular member until the end of the second tubular member abuts the external flange;

means for threadably coupling the ends of the first and second tubular members;

means for radially expanding and plastically deforming the first tubular member and the second tubular member;

means for placing the tubular sleeve in circumferential compression;

means for placing the end of the first tubular member in circumferential tension; and

means for placing the end of the second tubular member in circumferential tension.

228. A system, comprising:

means for providing a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve;

means for inserting an end of a first tubular member into an end of the tubular sleeve into abutment with the internal flange;

means for inserting an end of a second tubular member into another end of the tubular sleeve into abutment the internal flange;

means for threadably coupling the ends of the first and second tubular members;

means for radially expanding and plastically deforming only the portions of the first tubular member and the second tubular member proximate the threads of the first and second tubular members;

means for placing the tubular sleeve in circumferential tension;

means for placing the end of the first tubular member in circumferential compression; and

means for placing the end of the second tubular member in circumferential compression.

229. A system, comprising:

means for providing a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;

means for inserting an end of the tubular sleeve into an end of a first tubular member until the end of the first tubular member abuts with the external flange;

means for inserting another end of the tubular sleeve into an end of the second

tubular member until the end of the second tubular member abuts the external flange;

means for threadably coupling the ends of the first and second tubular members;

means for radially expanding and plastically deforming only the portions of the first tubular member and the second tubular member proximate the threads of the first and second tubular members;

means for placing the tubular sleeve in circumferential compression;

means for placing the end of the first tubular member in circumferential tension; and

means for placing the end of the second tubular member in circumferential tension.

230. A system for extracting geothermal energy from a subterranean source of geothermal energy, comprising:

means for drilling a borehole that traverses the subterranean source of geothermal energy;

means for positioning a first casing string within the borehole;

means for radially expanding and plastically deforming the first casing string within the borehole;

means for positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy;

means for overlapping a portion of the second casing string with a portion of the first casing string;

means for radially expanding and plastically deforming the second casing string within the borehole; and

means for extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings.

231. The system of claim 230, wherein the interior diameter of a passage defined by the first and second casing strings is constant.

232. The system of claim 230, wherein at least one of the first and second casing strings comprise:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member.

233. A system for extracting geothermal energy from a subterranean source of geothermal energy, comprising:

means for drilling a borehole that traverses the subterranean source of geothermal

energy;

means for positioning a first casing string within the borehole;

means for radially expanding and plastically deforming the first casing string within the borehole;

means for positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy;

means for overlapping a portion of the second casing string with a portion of the first casing string;

means for radially expanding and plastically deforming the second casing string within the borehole; and

means for extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings;

wherein the interior diameter of a passage defined by the first and second casing strings is constant; and

wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve;

a first tubular member received within an end of the tubular sleeve in abutment with the internal flange that comprises internal threads; and

a second tubular member received within another end of the tubular sleeve in abutment with the internal flange that comprises external threads that engage the internal threads of the first tubular member.

234. A system for extracting geothermal energy from a subterranean source of geothermal energy, comprising:

means for drilling a borehole that traverses the subterranean source of geothermal energy;

means for positioning a first casing string within the borehole;

means for radially expanding and plastically deforming the first casing string within the borehole;

means for positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy;

means for overlapping a portion of the second casing string with a portion of the first casing string;

means for radially expanding and plastically deforming the second casing string within the borehole; and

means for extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings;

wherein the interior diameter of a passage defined by the first and second casing strings is constant; and

wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;

a first tubular member that receives an end of the tubular sleeve that abuts external flange that comprises internal threads; and

a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first tubular member.

235. A system for extracting geothermal energy from a subterranean source of geothermal energy, comprising:

means for drilling a borehole that traverses the subterranean source of geothermal energy;

means for positioning a first casing string within the borehole;

means for radially expanding and plastically deforming the first casing string within the borehole;

means for positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy;

means for overlapping a portion of the second casing string with a portion of the first casing string;

means for radially expanding and plastically deforming the second casing string within the borehole; and

means for extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings;

wherein the interior diameter of a passage defined by the first and second casing strings is constant; and

wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve;

a first tubular member received within an end of the tubular sleeve in abutment with the internal flange that comprises internal threads; and

a second tubular member received within another end of the tubular sleeve in abutment with the internal flange that comprises external threads that engage the internal threads of the first tubular member;

wherein the tubular sleeve is in circumferential tension;

wherein the first tubular member is in circumferential compression;

wherein the second tubular member is in circumferential compression;

wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members; and

wherein a fluid tight seal is provided between the threads of the first and second tubular members.

236. A system for extracting geothermal energy from a subterranean source of geothermal energy, comprising:

means for drilling a borehole that traverses the subterranean source of geothermal energy;

means for positioning a first casing string within the borehole;

means for radially expanding and plastically deforming the first casing string within the borehole;

means for positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy;

means for overlapping a portion of the second casing string with a portion of the first casing string;

means for radially expanding and plastically deforming the second casing string within the borehole; and

means for extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings;

wherein the interior diameter of a passage defined by the first and second casing strings is constant; and

wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;

a first tubular member that receives an end of the tubular sleeve that abuts external flange that comprises internal threads; and

a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first tubular member;

wherein the tubular sleeve is in circumferential compression;

wherein the first tubular member is in circumferential tension;

wherein the second tubular member is in circumferential tension;

wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members; and

wherein a fluid tight seal is provided between the threads of the first and second tubular members.

237. A system, comprising:

means for coupling the ends of first and second tubular members;

means for injecting a pressurized fluid through the first and second tubular members;

means for determining if any of the pressurized fluid leaks through the coupled ends of the first and second tubular members; and

means for if a predetermined amount of the pressurized fluid leaks through the coupled ends of the first and second tubular members, then coupling a tubular sleeve to the ends of the first and second tubular members and radially expanding and plastically deforming only the portions of the first and second tubular members proximate the tubular sleeve.

238. The system of claim 237, wherein means for radially expanding and plastically deforming only the portions of the first and second tubular members proximate the tubular sleeve comprises:

means for displacing an expansion cone within and relative to the first and second tubular members.

239. The system of claim 237, wherein means for radially expanding and plastically deforming only the portions of the first and second tubular members proximate the tubular sleeve comprises:

means for applying radial pressure to the interior surfaces of the first and second tubular member proximate the tubular sleeve using a rotating member.

240. The system of claim 167, further comprising:

means for transmitting energy through the first and second tubular members.

241. The system of claim 240, wherein the energy comprises electrical energy.

242. The system of claim 241, wherein the electrical energy comprises a communication signal.

243. The system of claim 240, wherein the energy comprises thermal energy.

244. The system of claim 240, wherein the energy comprises acoustic energy.

245. The system of claim 240, wherein the energy is transmitted through the first and second tubular members prior to radially expanding and plastically deforming the first and second tubular members.

246. The system of claim 240, wherein the energy is transmitted through the first and second tubular members after radially expanding and plastically deforming the first and second tubular members.

247. The system of claim 198, further comprising:

means for transmitting energy through the first and second tubular members.

248. The system of claim 247, wherein the energy comprises electrical energy.

249. The system of claim 248, wherein the electrical energy comprises a communication

signal.

250. The system of claim 247, wherein the energy comprises thermal energy.

251. The system of claim 247, wherein the energy comprises acoustic energy.

252. The system of claim 247, wherein the energy is transmitted through the first and second tubular members prior to radially expanding and plastically deforming the first and second tubular members.

253. The system of claim 247, wherein the energy is transmitted through the first and second tubular members after radially expanding and plastically deforming the first and second tubular members.

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(62) Divided from Application No
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(continued on next page)

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E21B 43/10 19/16

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E1F FGR FGR5 FLA

(56) Documents Cited:
GB 2399579 A WO 2002/068792 A1

(58) Field of Search:
UK CL (Edition X) E1F
INT CL^7 E21B
Other: Online: WPI, EPODOC

(54) Abstract Title: **Mono-diameter wellbore casing**

(57) A constant diameter wellbore casing comprises a casing 115 and a liner 210 that are overlappingly coupled. The liner is radially expanded into contact with the casing by extruding from a first expansion device, preferably a cone (205, fig 4), preferably using fluid pressure. The overlap between the liner and casing is then expanded, preferably using a shaped charge, and the portion of the tubular that does not overlap the casing is expanded using a second expansion device or cone 705.

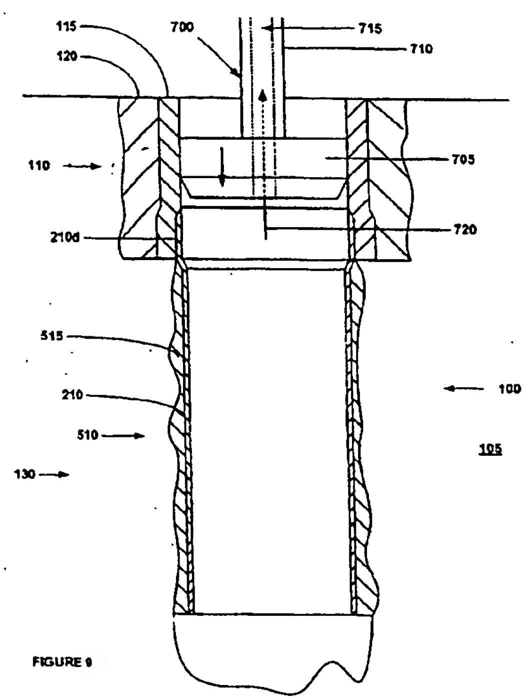

FIGURE 9

GB 2 408 278 A

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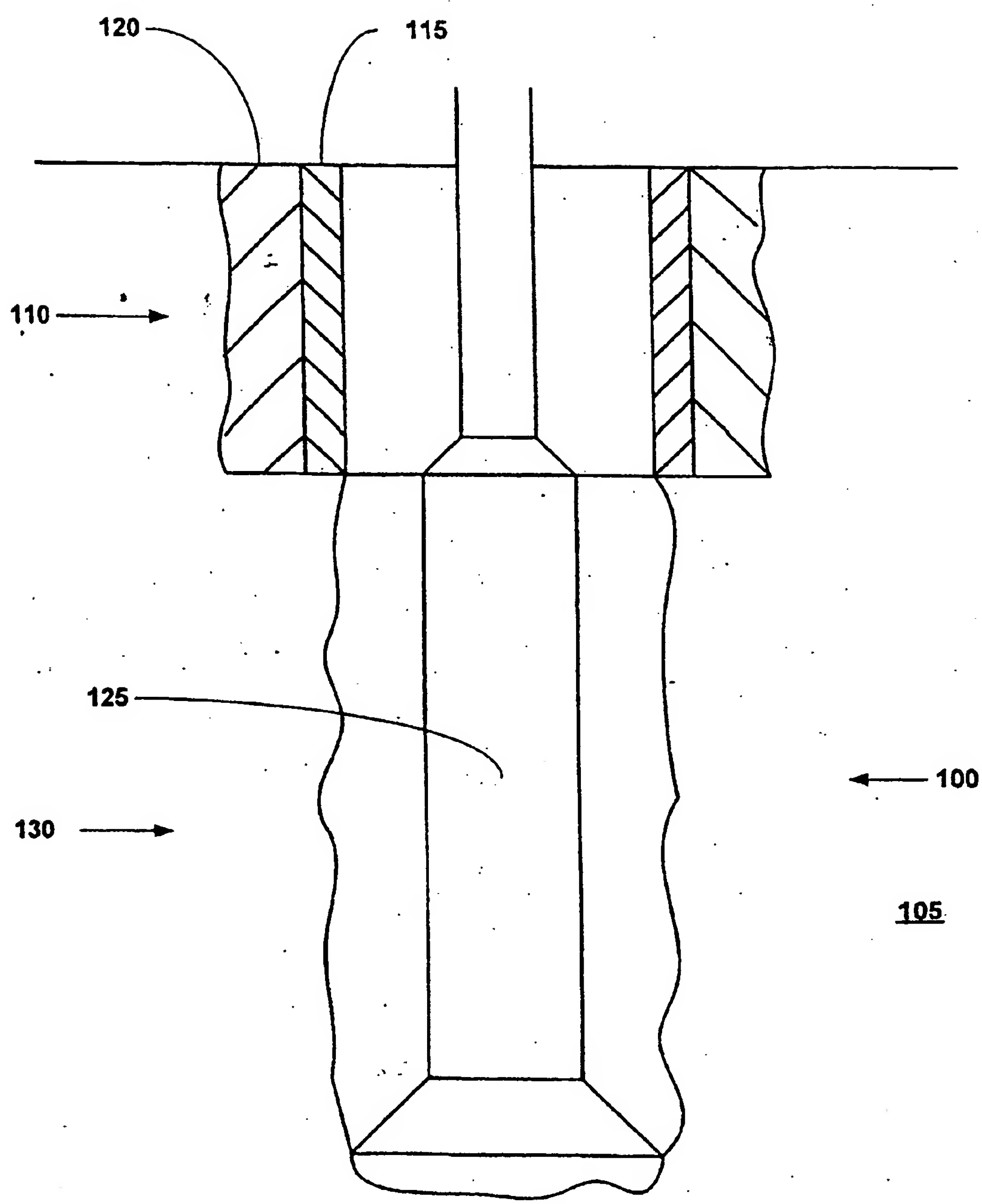

FIGURE 1

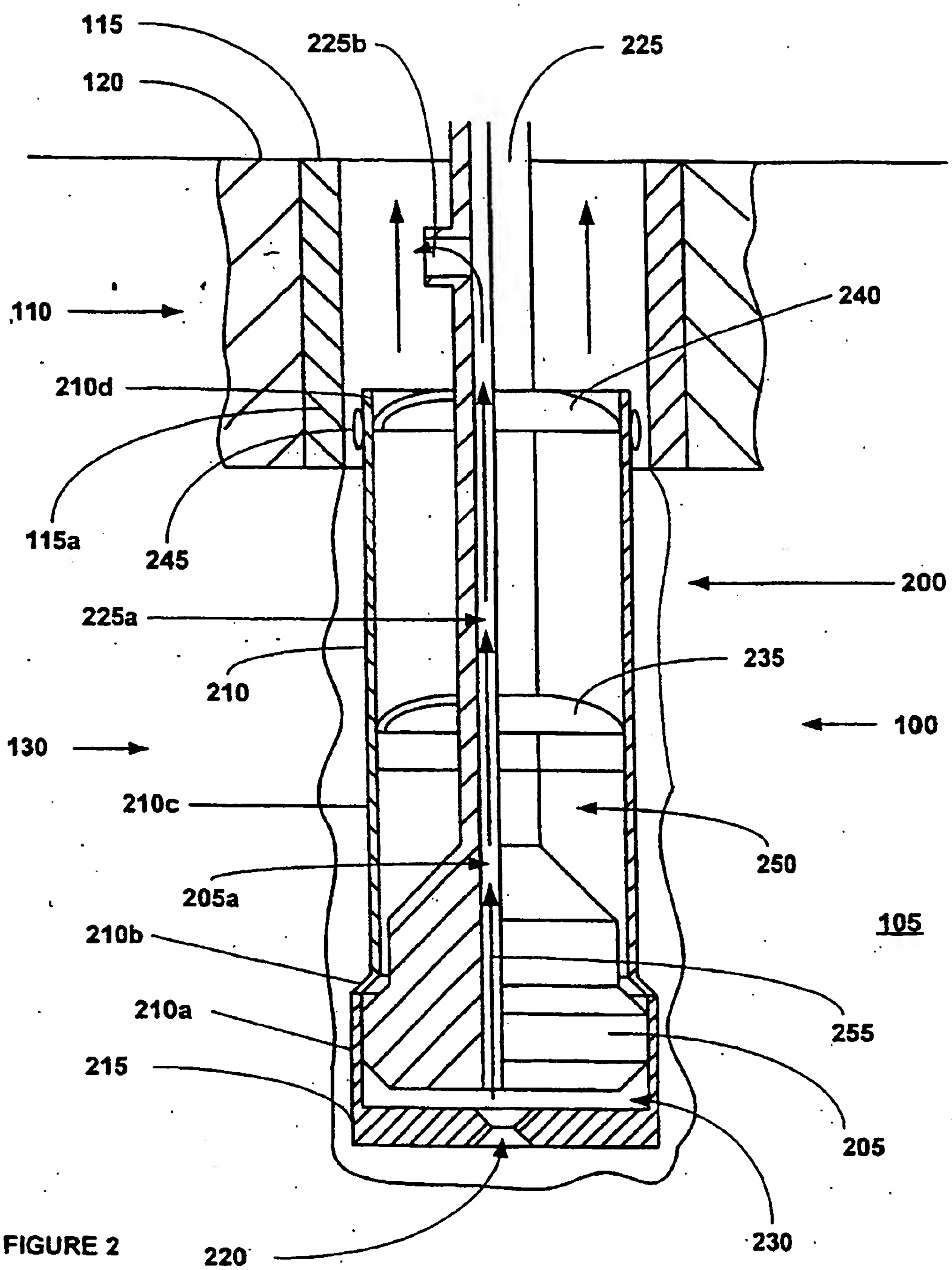
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FIGURE 2

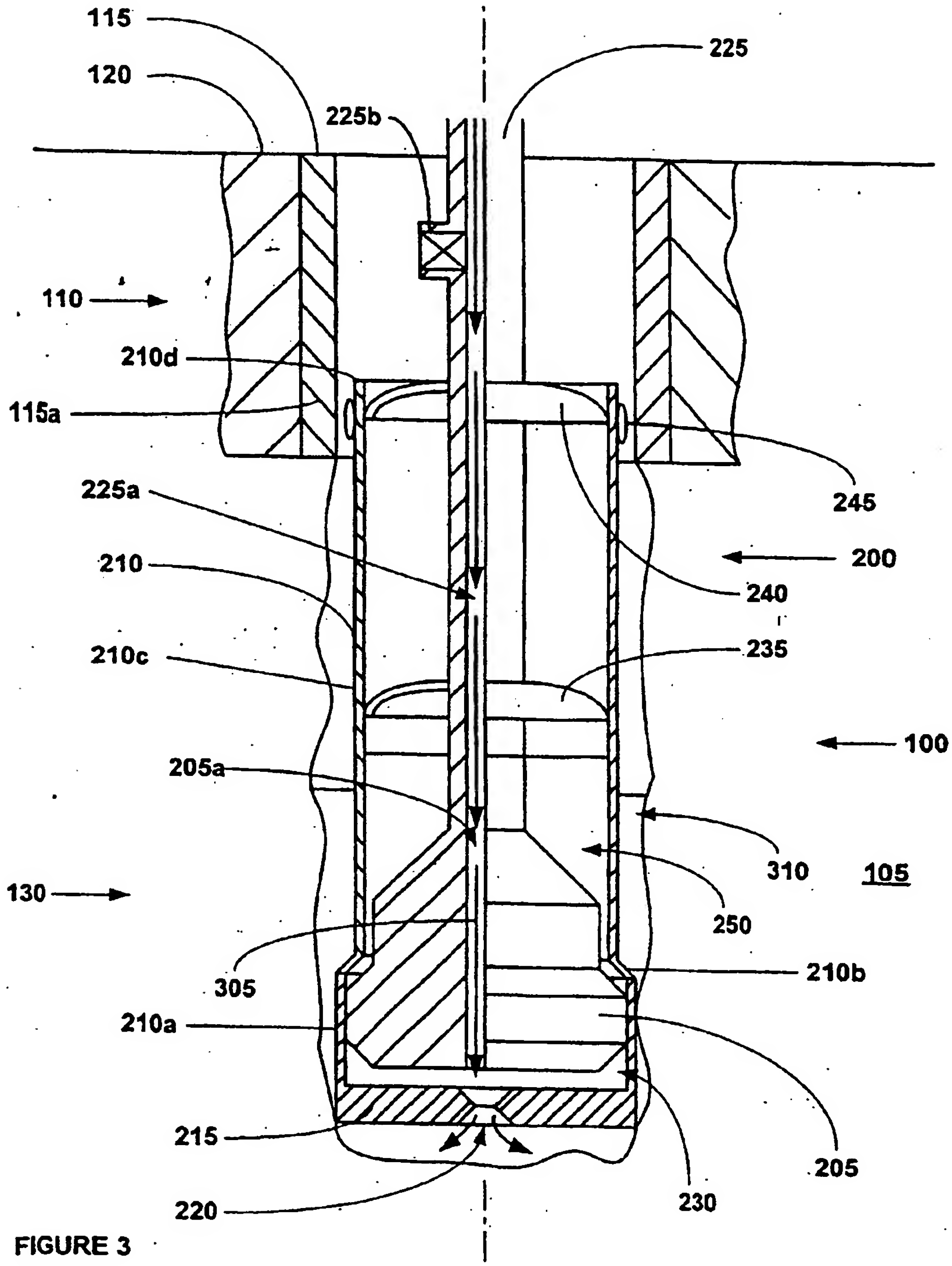

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FIGURE 3

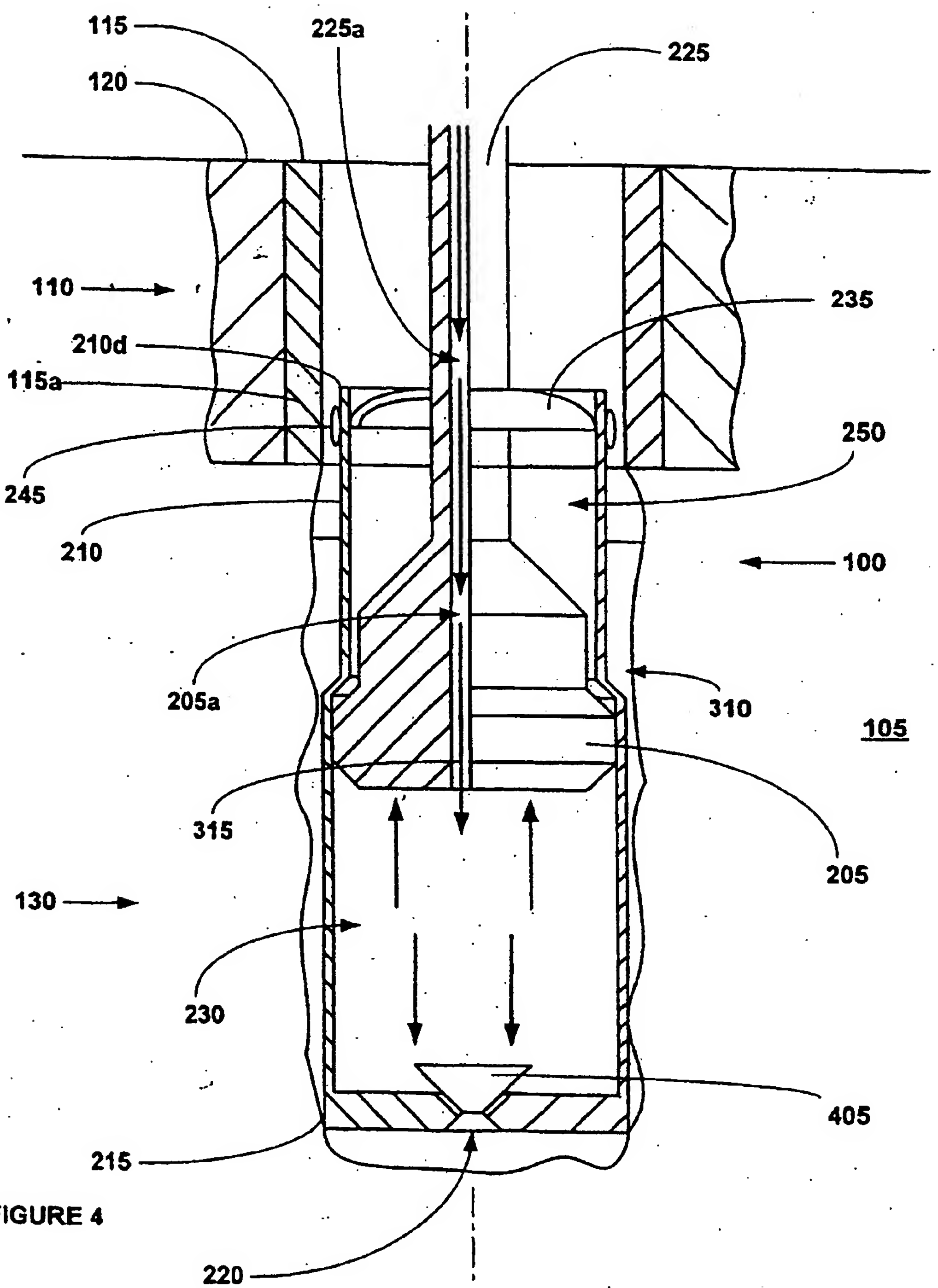
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FIGURE 4

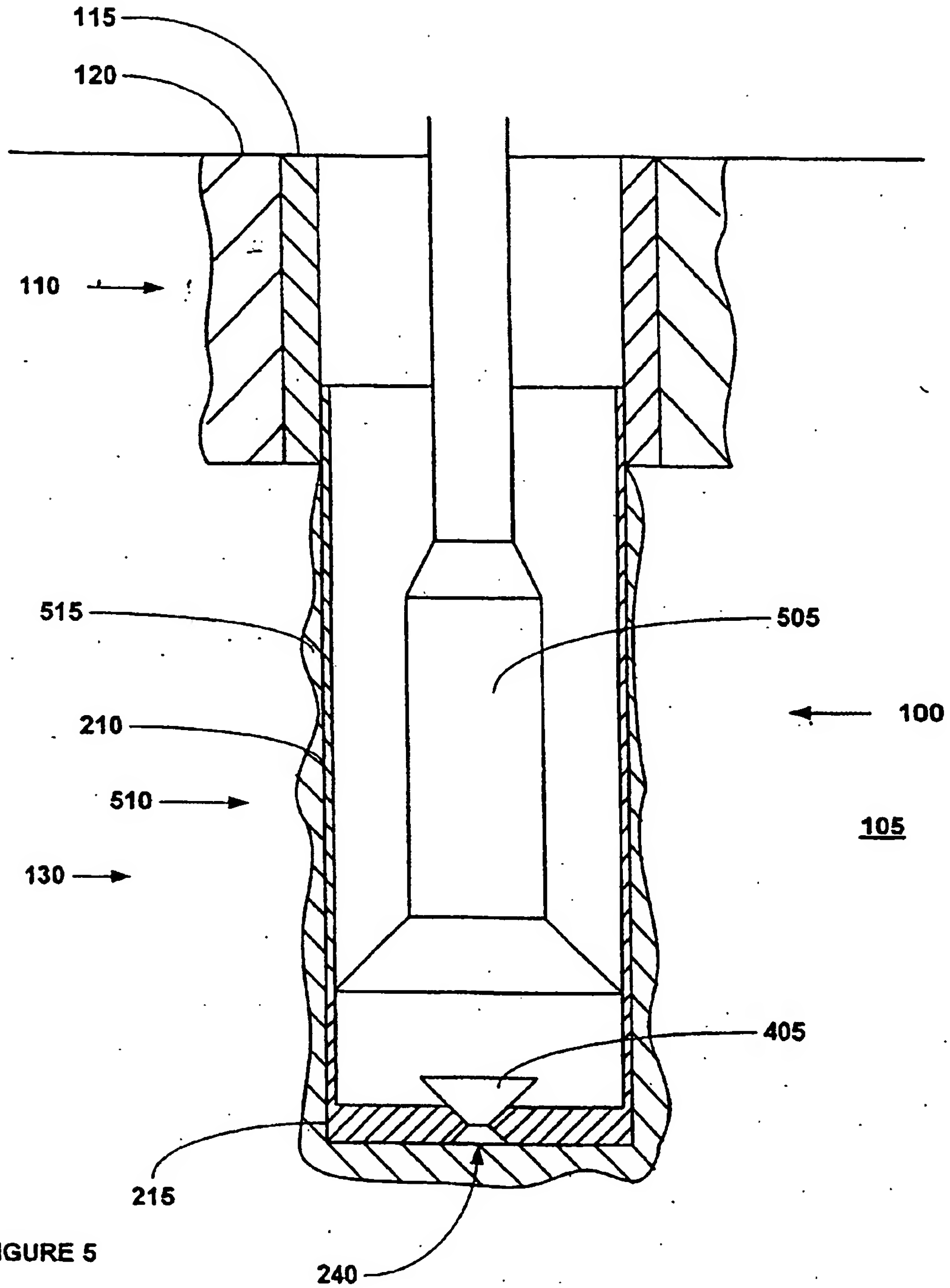


FIGURE 5

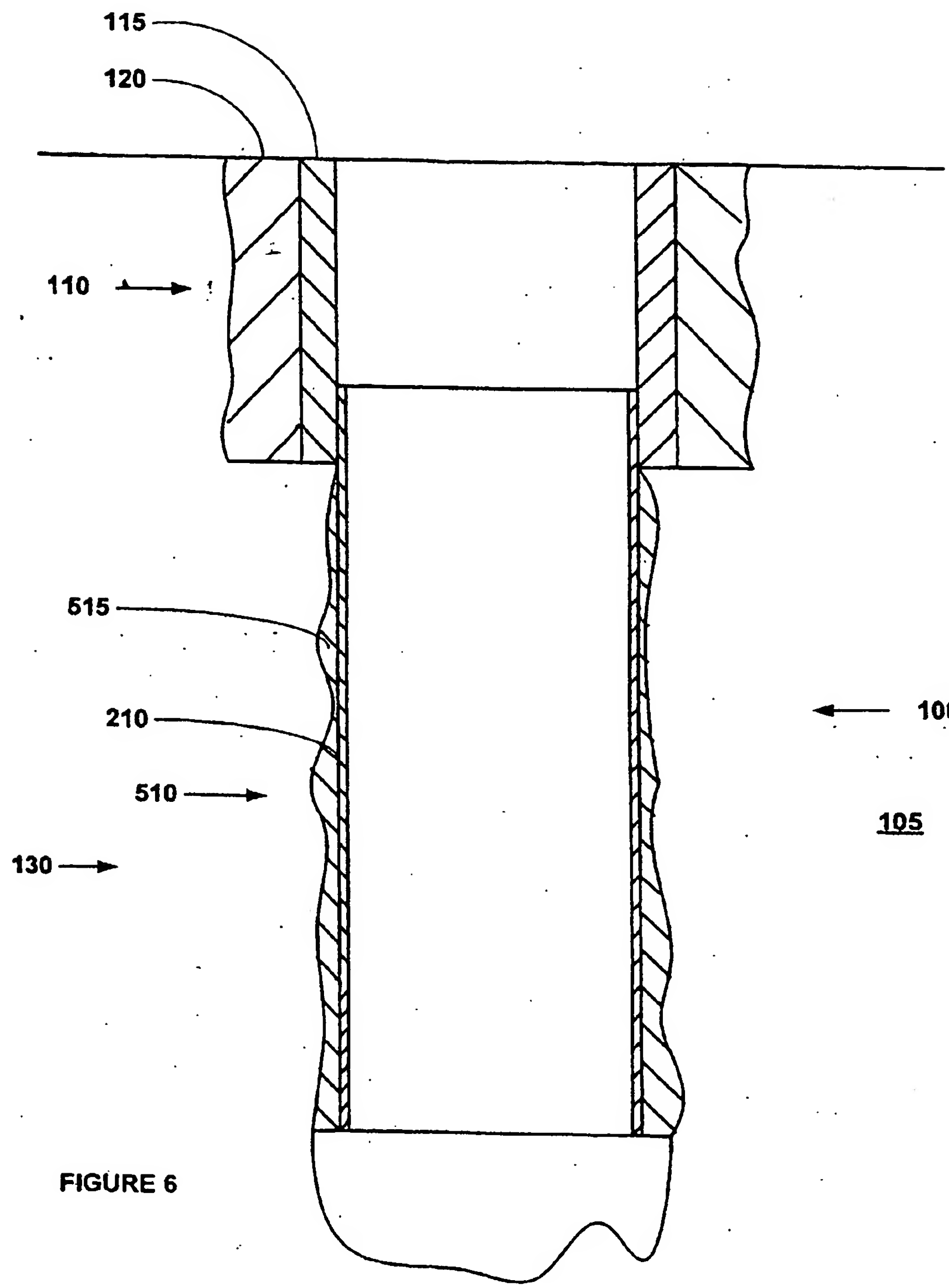
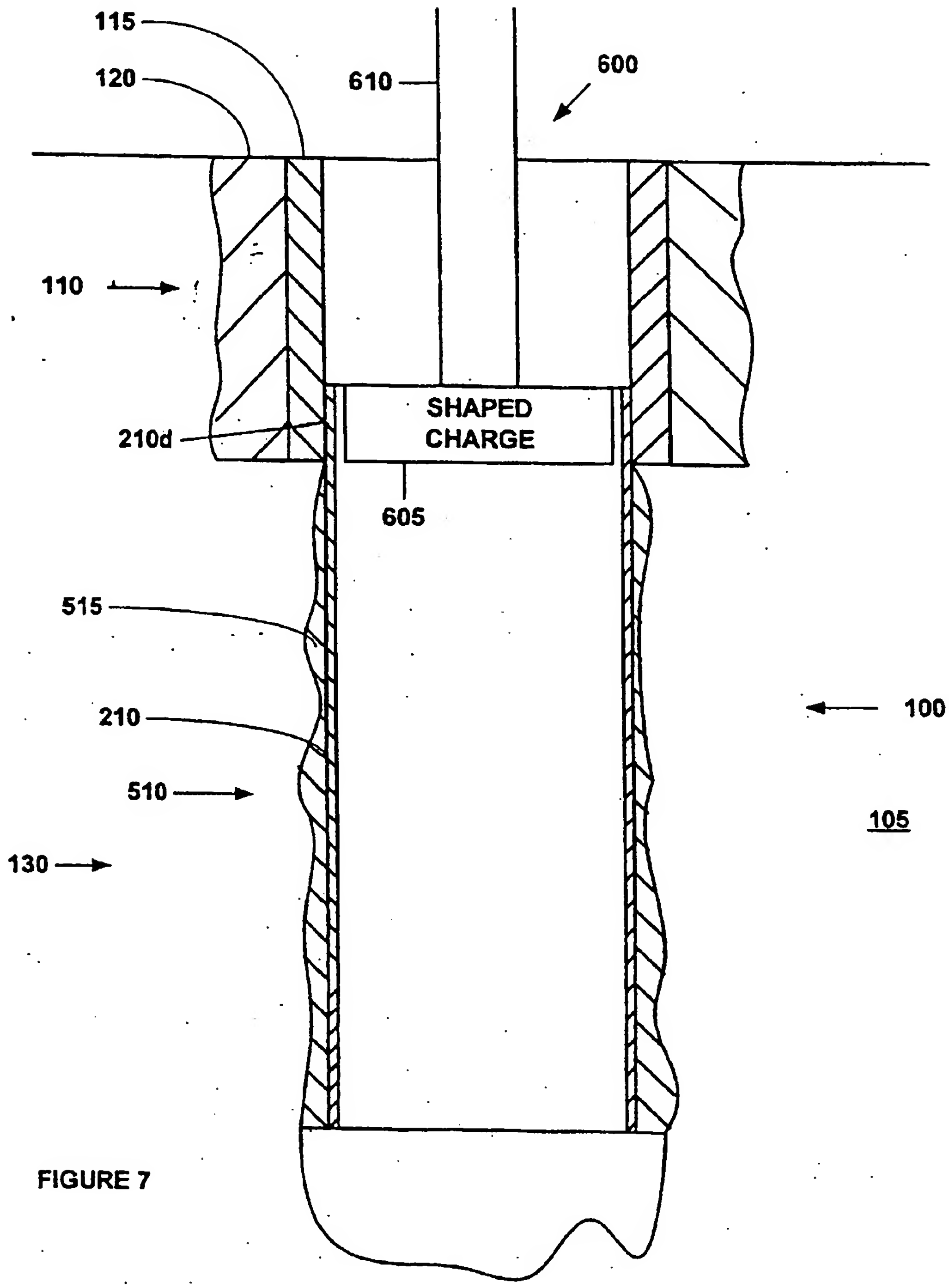


FIGURE 6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510
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130

FIGURE 7

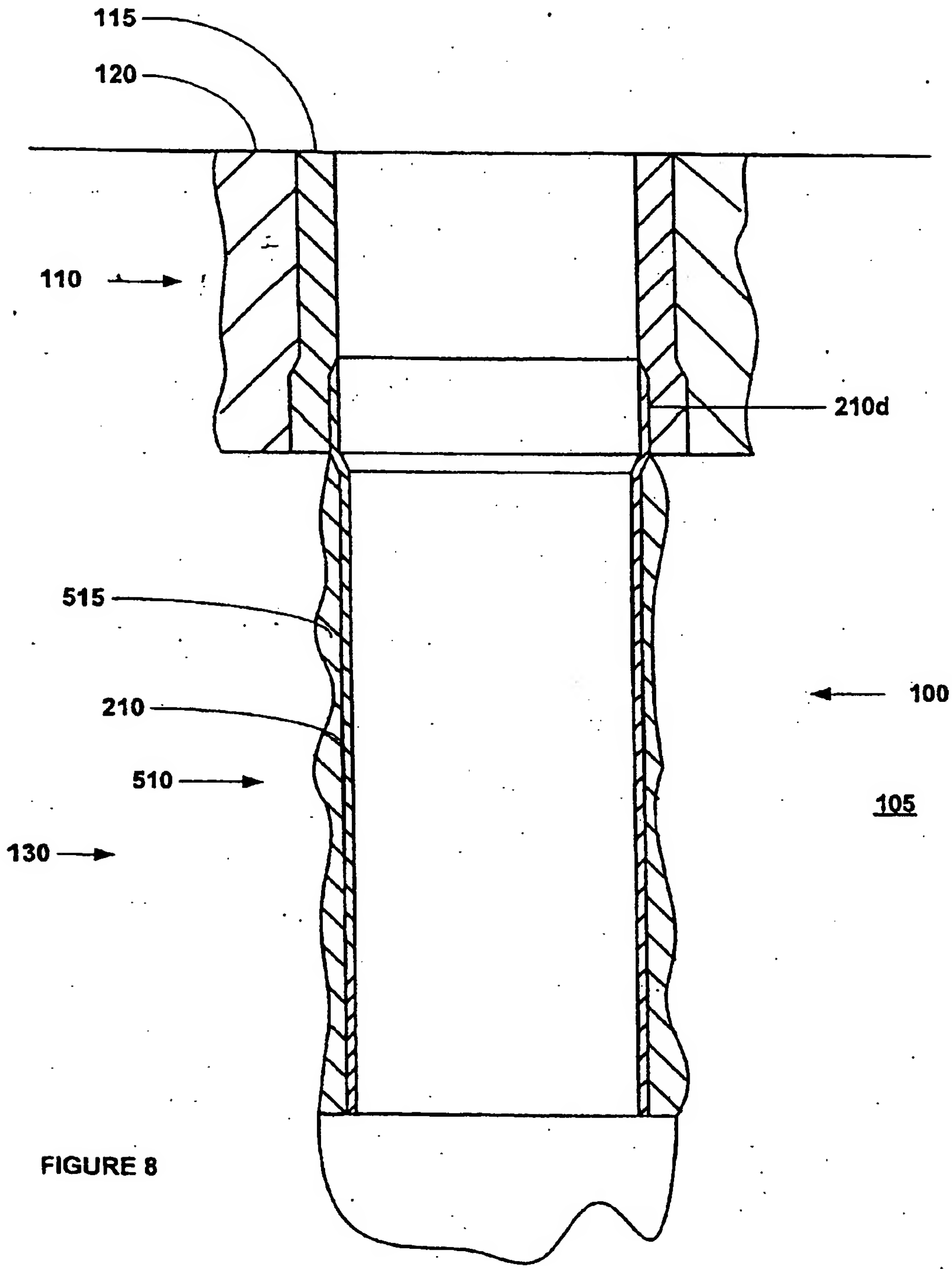


FIGURE 8

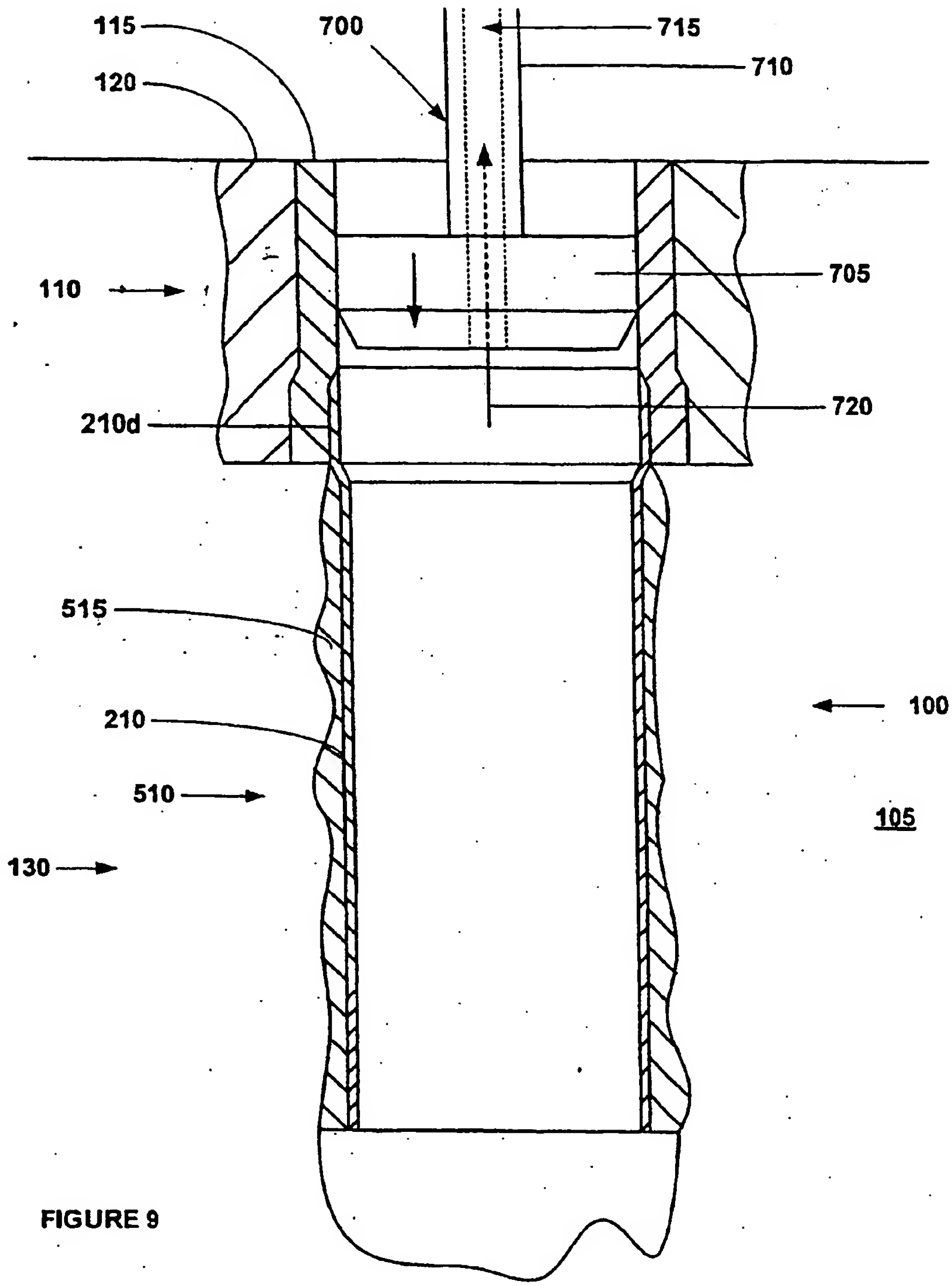


FIGURE 9

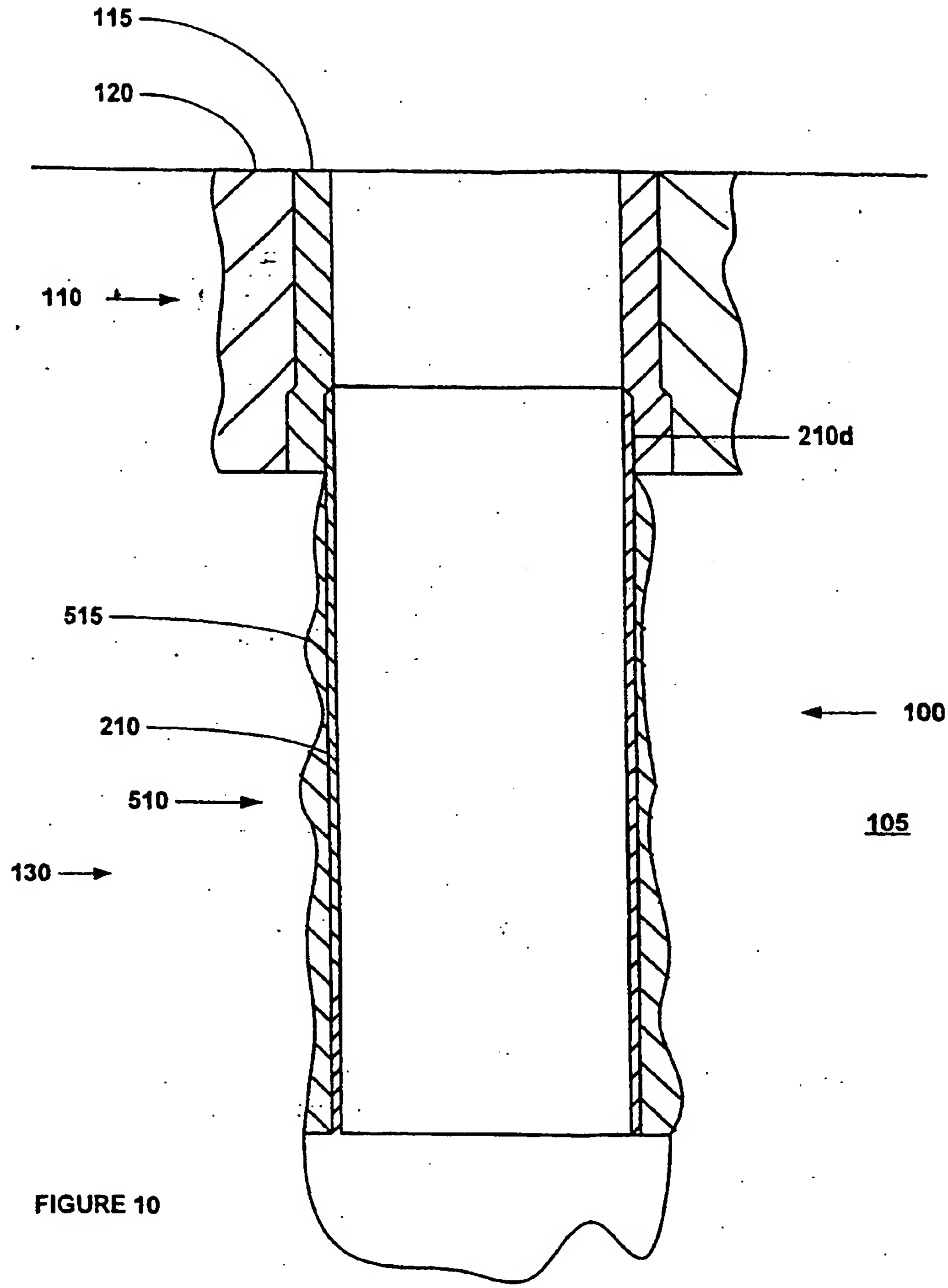


FIGURE 10

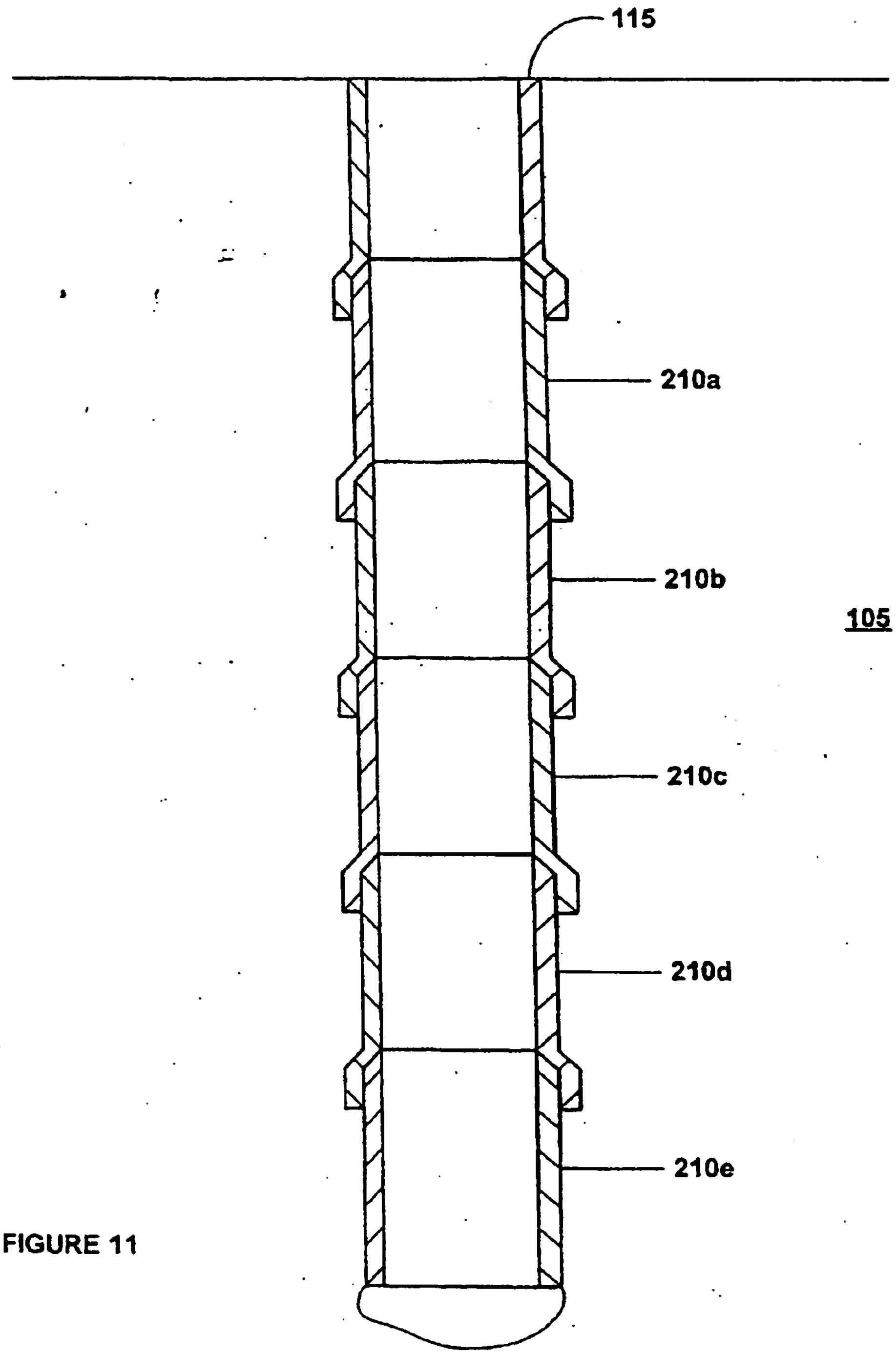
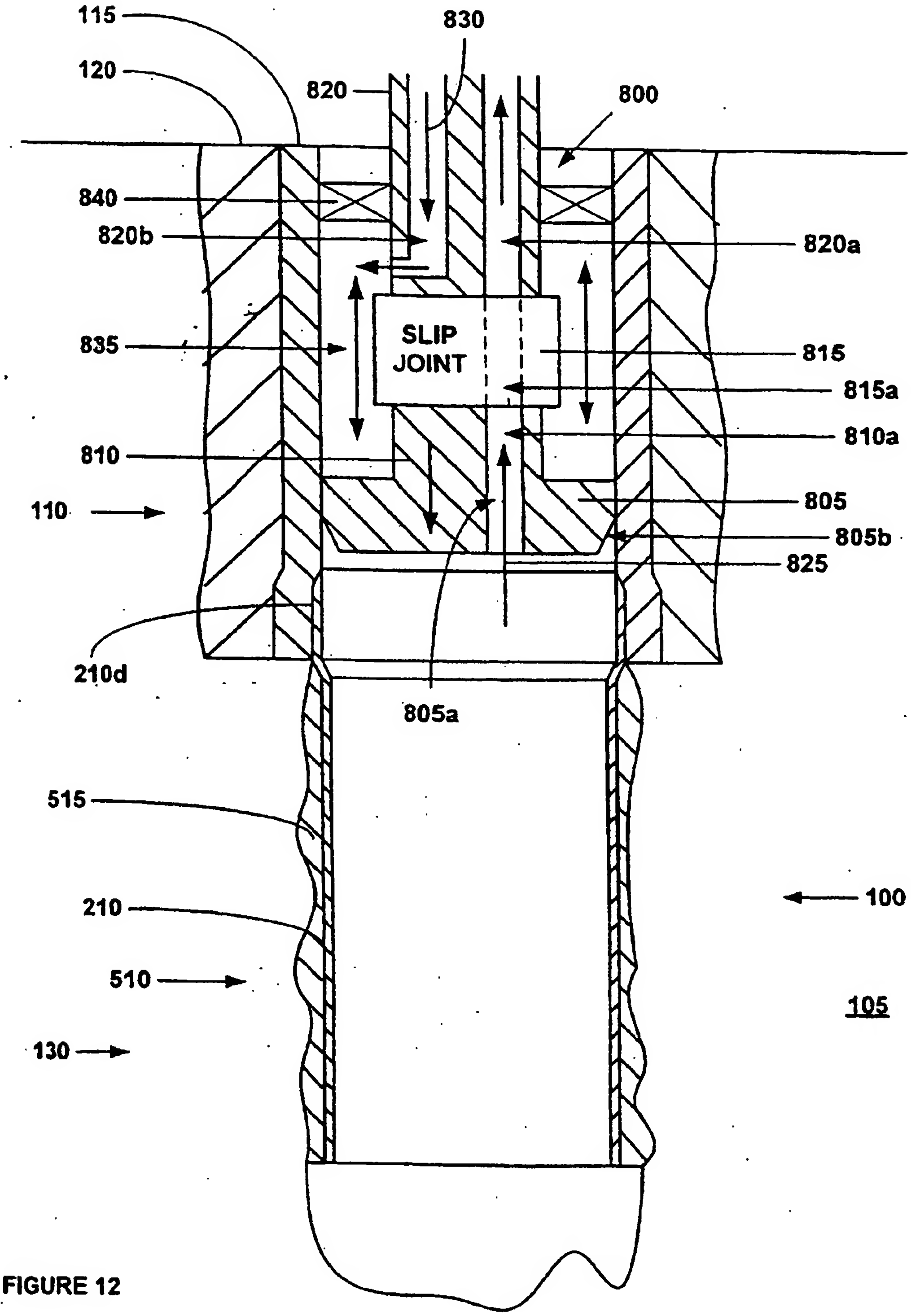


FIGURE 11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805
110
805b
825
210d
805a
515
100
210
510
105
130

FIGURE 12

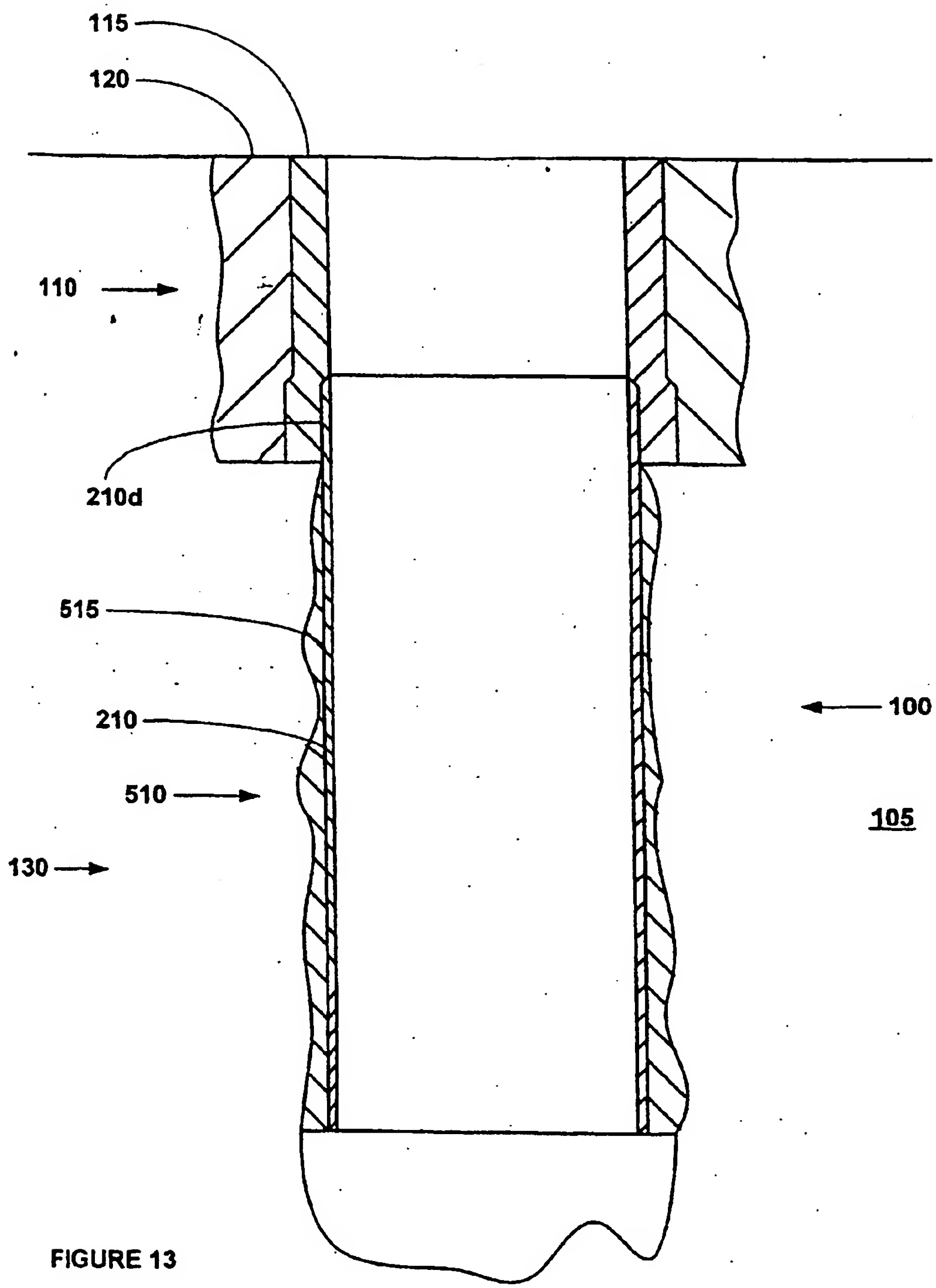


FIGURE 13

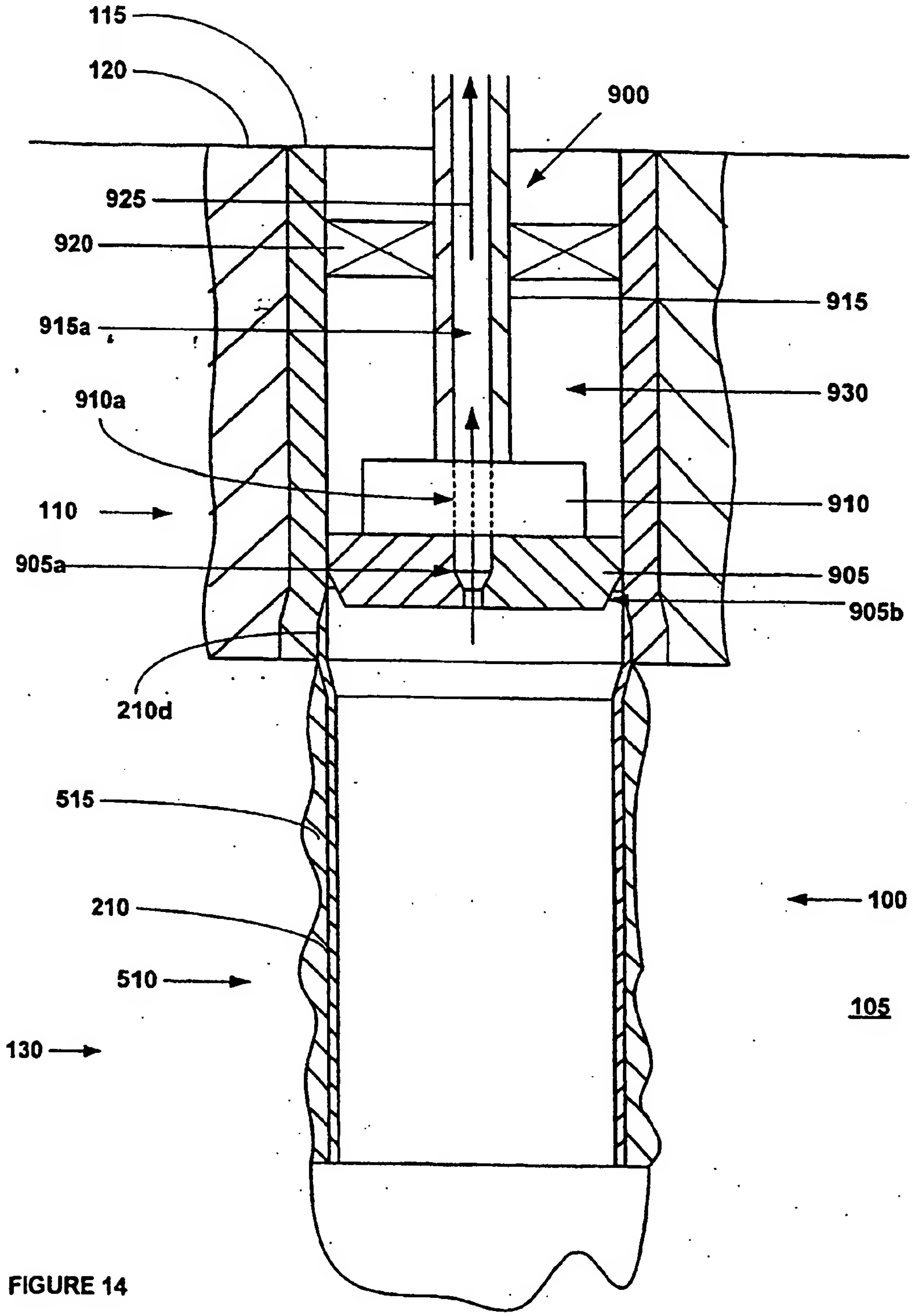

115
120
900
925
920
915
915a
930
910a
910
110
905a
905
905b
210d
515
210
100
510
105
130

FIGURE 14

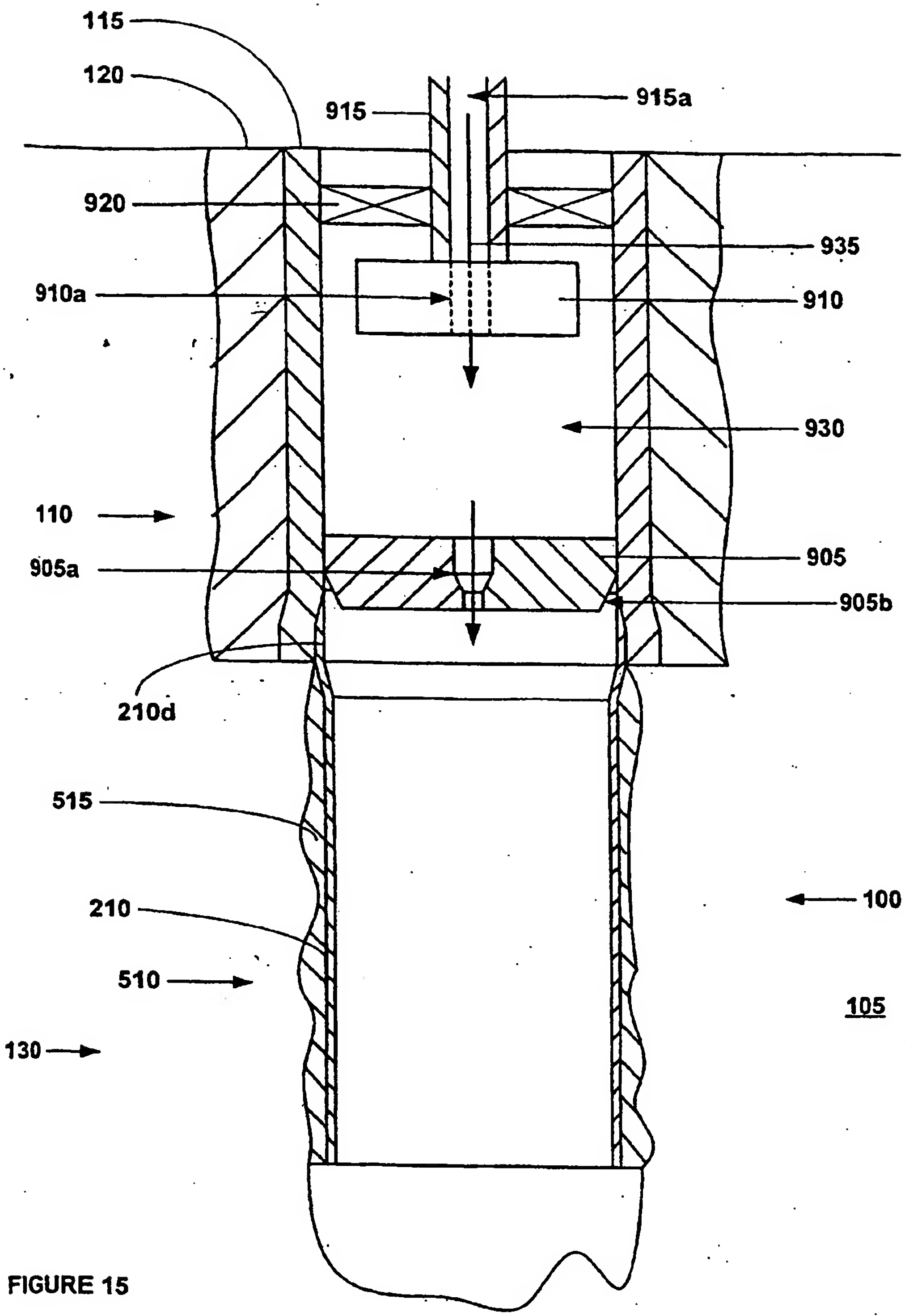
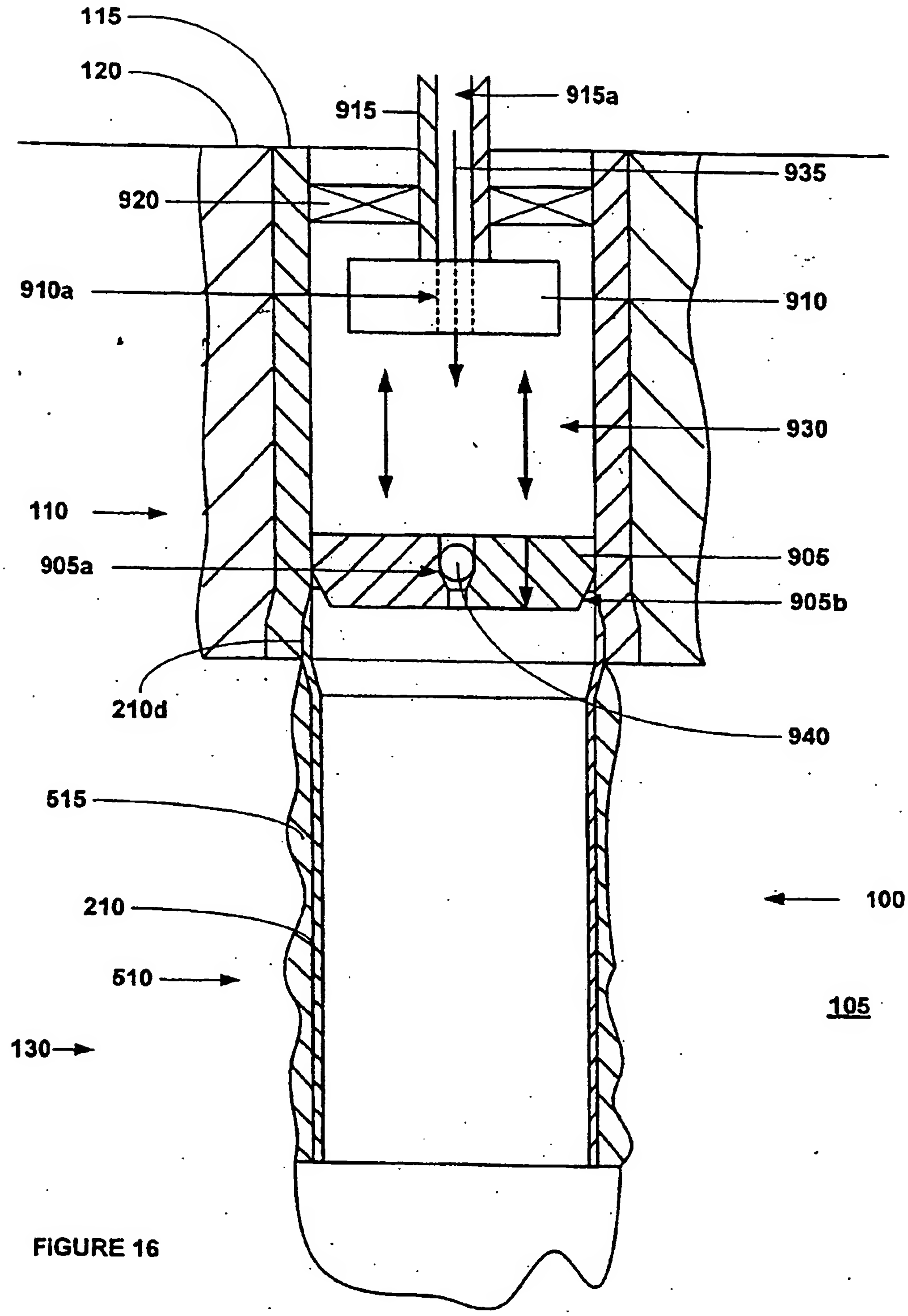

115
120
915
915a
920
935
910a
910
930
110
905a
905
905b
210d
515
100
210
510
105
130

FIGURE 15



115
120
915
915a
935
920
910a
910
930
110
905
905a
905b
210d
940
515
100
210
510
105
130

FIGURE 16

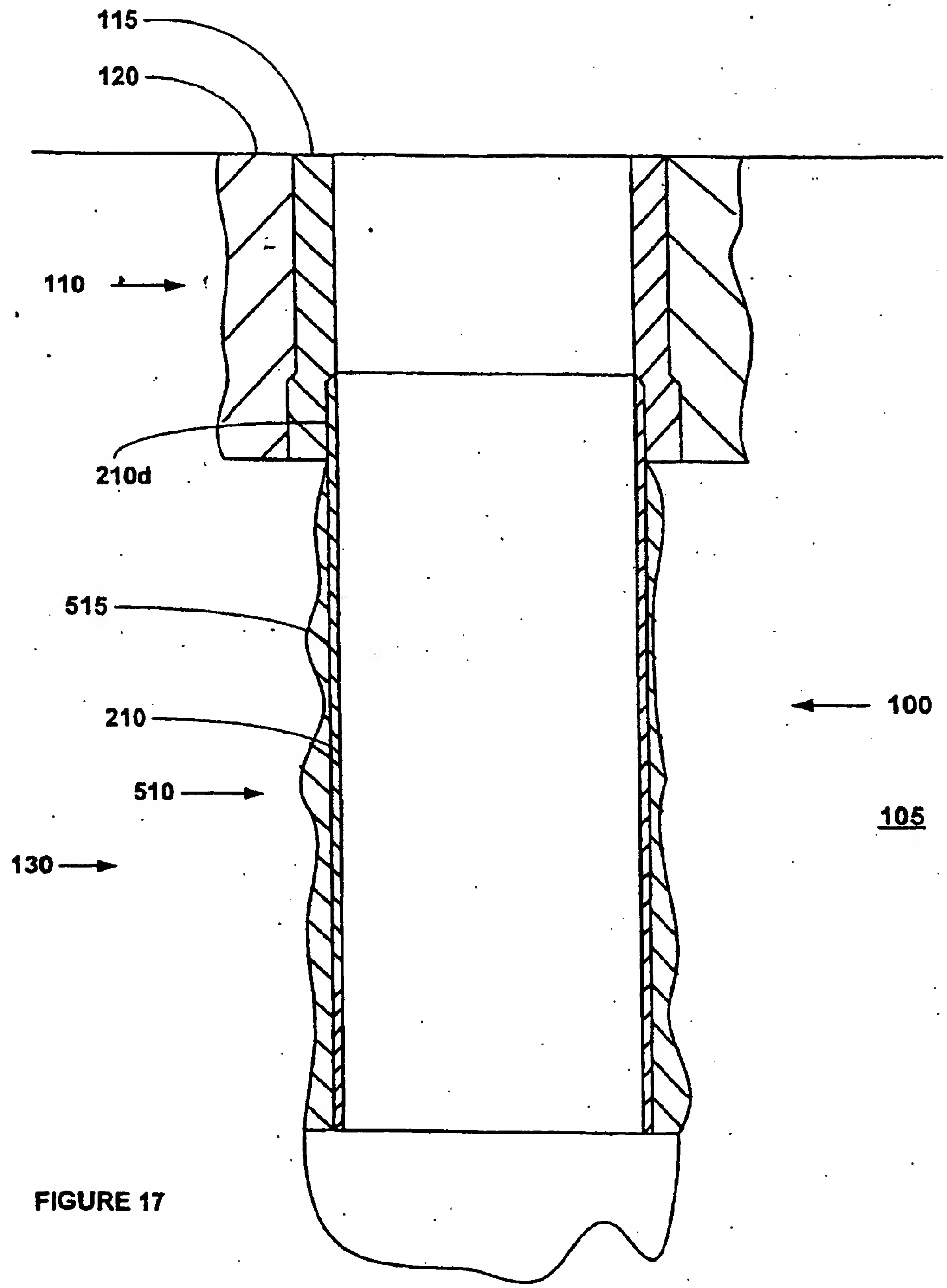


FIGURE 17

MONO-DIAMETER WELLBORE CASING

Cross Reference To Related Applications

The present application claims the benefit of the filing date of U.S. provisional patent application serial no. 60/326,886, attorney docket no. 25791.60, filed on 10/03/2001, the disclosure of which is incorporated herein by reference.

This application is a continuation-in-part of: (1) U.S. utility application serial number 09/454,139, attorney docket number 25791.3.02, filed on 12/3/1999, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/111,293, attorney docket number 25791.3, filed on 12/7/1998, and (2) U.S. provisional application serial number 60/262,434, attorney docket number 25791.51, filed on 1/17/2001, the disclosures of which are incorporated herein by reference.

The present application is related to the following: (1) U.S. patent application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, (3) U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, (4) U.S. patent application serial no. 09/440,338, attorney docket no. 25791.9.02, filed on 11/15/1999, (5) PCT patent application serial no. PCT/US01/04753, attorney docket no. 25791.10.02, filed on 2/14/2001, (6) U.S. patent application serial no. 09/523,460, attorney docket no. 25791.11.02, filed on 3/10/2000, (7) U.S. patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, (8) U.S. patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on 2/24/2000, (9) U.S. patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, (10) U.S. patent application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, (11) PCT patent application serial no. PCT/US00/18635, attorney docket no. 25791.25.02, filed on 7/9/2000, (12) PCT patent application serial no. PCT/US00/30022, attorney docket no. 25791.27.02, filed on 10/31/2000, (13) U.S. patent application serial no. 09/679,907, attorney docket no. 25791.34.02, filed on 10/5/2000, (14) PCT patent application serial no. PCT/US00/27645, attorney docket no. 25791.36.02, filed on 10/5/2000, (15) U.S. patent application serial no. 09/679,906, attorney docket no. 25791.37.02, filed on 10/5/2000, (16) PCT patent application serial no. PCT/US01/19014, attorney docket no. 25791.38.02, filed on 6/12/2001, (17) PCT patent application serial no. PCT/US01/41446, attorney docket no. 25791.45.02, filed on 7/28/2001, (18) PCT patent application serial no. PCT/US01/23815, attorney docket no. 25791.46.02, filed on 7/27/2001, (19) PCT patent application serial no. PCT/US01/28960, attorney docket no. 25791.47.02, filed on 9/17/2001, (20) U.S.

provisional patent application serial no. 60/237,334, attorney docket no. 25791.48, filed on 10/2/2000, (21) U.S. provisional patent application serial no. 60/270,007, attorney docket no. 25791.50, filed on 2/20/2001; (22) U.S. provisional patent application serial no. 60/262,434, attorney docket no. 25791.51, filed on 1/17/2001; (23) U.S. provisional patent application serial no. 60/259,486, attorney docket no. 25791.52, filed on 1/3/2001; (24) U.S. provisional patent application serial no. 60/303,740, attorney docket no. 25791.61, filed on 7/6/2001; (25) U.S. provisional patent application serial no. 60/313,453, attorney docket no. 25791.59, filed on 8/20/2001; (26) PCT patent application serial no. PCT/US02/24399, attorney docket no. 25791.59.02, filed on 8/1/02, (27) U.S. provisional patent application serial no. 60/317,985, attorney docket no. 25791.67, filed on 9/6/2001, (28) U.S. provisional patent application serial no. 60/318,021, attorney docket no. 25791.58, filed on 9/7/2001, (29) PCT patent application serial no. PCT/US________________, attorney docket no. 25791.58.02 filed on 8/13/02, (30) U.S. provisional patent application serial no. 60/318,386, attorney docket no. 25791.67.02, filed on 9/10/2001 and (31) PCT patent application serial no. PCT/US_______________, attorney docket no. 25791.67.03, filed on 8/14/02, the disclosures of which are incorporated herein by reference.

Background of the Invention

This invention relates generally to wellbore casings, and in particular to wellbore casings that are formed using expandable tubing.

Conventionally, when a wellbore is created, a number of casings are installed in the borehole to prevent collapse of the borehole wall and to prevent undesired outflow of drilling fluid into the formation or inflow of fluid from the formation into the borehole. The borehole is drilled in intervals whereby a casing which is to be installed in a lower borehole interval is lowered through a previously installed casing of an upper borehole interval. As a consequence of this procedure the casing of the lower interval is of smaller diameter than the casing of the upper interval. Thus, the casings are in a nested arrangement with casing diameters decreasing in downward direction. Cement annuli are provided between the outer surfaces of the casings and the borehole wall to seal the casings from the borehole wall. As a consequence of this nested arrangement a relatively large borehole diameter is required at the upper part of the wellbore. Such a large borehole diameter involves increased costs due to heavy casing handling equipment, large drill bits and increased volumes of drilling fluid and drill cuttings. Moreover, increased drilling rig time is involved due to required cement pumping, cement hardening, required equipment changes due to large variations in hole

diameters drilled in the course of the well, and the large volume of cuttings drilled and removed.

The present invention is directed to overcoming one or more of the limitations of the existing procedures for forming new sections of casing in a wellbore.

Summary of the Invention

According to one aspect of the present invention, a method of creating a mono-diameter wellbore casing in a borehole located in a subterranean formation including a preexisting wellbore casing is provided that includes installing a tubular liner and a first expansion cone in the borehole, injecting a fluidic material into the borehole, pressurizing a portion of an interior region of the tubular liner below the first expansion cone, radially expanding at least a portion of the tubular liner in the borehole by extruding at least a portion of the tubular liner off of the first expansion cone, radially expanding an overlap between the preexisting wellbore casing and the tubular liner, and radially expanding the portion of the tubular liner that does not overlap with the preexisting wellbore casing using a second expansion cone.

According to another aspect of the present invention, a system for creating a mono-diameter wellbore casing in a borehole located in a subterranean formation including a preexisting wellbore casing is provided that includes means for installing a tubular liner and a first expansion cone in the borehole, means for injecting a fluidic material into the borehole, means for pressurizing a portion of an interior region of the tubular liner below the first expansion cone, means for radially expanding at least a portion of the tubular liner in the borehole by extruding at least a portion of the tubular liner off of the first expansion cone, means for radially expanding an overlap between the preexisting wellbore casing and the tubular liner, and means for radially expanding the portion of the tubular liner that does not overlap with the preexisting wellbore casing using a second expansion cone.

According to another aspect of the present invention, a method of creating a tubular structure having a substantially constant inside diameter is provided that includes installing a first tubular member and a first expansion cone within a second tubular member, injecting a fluidic material into the second tubular member, pressurizing a portion of an interior region of the first tubular member below the first expansion cone, radially expanding at least a portion of the first tubular member in the second tubular member by extruding at least a portion of the first tubular member off of the first expansion cone, radially expanding an overlap between the first and second tubular members, and radially expanding the portion of the first tubular member that does not overlap with the second tubular member using a second expansion cone.

According to another aspect of the present invention, a system for creating a tubular structure having a substantially constant inside diameter is provided that includes means for installing a first tubular member and a first expansion cone within a second tubular member, means for injecting a fluidic material into the second tubular member, means for pressurizing a portion of an interior region of the first tubular member below the first expansion cone, means for radially expanding at least a portion of the first tubular member in the second tubular member by extruding at least a portion of the first tubular member off of the first expansion cone, means for radially expanding an overlap between the first and second tubular members, and means for radially expanding the portion of the first tubular member that does not overlap with the second tubular member using a second expansion cone.

According to another aspect of the present invention, an apparatus is provided that includes a subterranean formation including a borehole, a wellbore casing coupled to the borehole, and a tubular liner overlappingly coupled to the wellbore casing, wherein the inside diameter of the portion of the wellbore casing that does not overlap with the tubular liner is substantially equal to the inside diameter of the tubular liner, and wherein the tubular liner is coupled to the wellbore casing by a method including installing the tubular liner and a first expansion cone in the borehole, injecting a fluidic material into the borehole, pressurizing a portion of an interior region of the tubular liner below the first expansion cone, radially expanding at least a portion of the tubular liner in the borehole by extruding at least a portion of the tubular liner off of the first expansion cone, radially expanding an overlap between the wellbore casing and the tubular liner, and radially expanding the portion of the tubular liner that does not overlap with the wellbore casing using a second expansion cone.

According to another aspect of the present invention, an apparatus is provided that includes a first tubular member, and a second tubular member overlappingly coupled to the first tubular member, wherein the inside diameter of the portion of the first tubular member that does not overlap with the second tubular member is substantially equal to the inside diameter of the second tubular member, and wherein the second tubular member is coupled to the first tubular member by a method that includes installing the second tubular member and a first expansion cone in the first tubular member, injecting a fluidic material into the first tubular member, pressurizing a portion of an interior region of the second tubular member below the first expansion cone, radially expanding at least a portion of the second tubular member in the first tubular member by extruding at least a portion of the tubular liner off of the first expansion cone, radially expanding an overlap between the first and second tubular

members, and radially expanding the portion of the second tubular member that does not overlap with the first tubular member using a second expansion cone.

Brief Description of the Drawings

FIG. 1 is a fragmentary cross-sectional view illustrating the drilling of a new section of a well borehole in a borehole including a preexisting section of wellbore casing.

FIG. 2 is a fragmentary cross-sectional view illustrating the placement of an embodiment of an apparatus for creating a casing within the new section of the well borehole of FIG. 1.

FIG. 3 is a fragmentary cross-sectional view illustrating the injection of a hardenable fluidic sealing material into the new section of the well borehole of FIG. 2.

FIG. 4 is a fragmentary cross-sectional view illustrating the injection of a fluidic material into the new section of the well borehole of FIG. 3.

FIG. 5 is a fragmentary cross-sectional view illustrating the drilling out of the cured hardenable fluidic sealing material and the shoe from the new section of the well borehole of FIG. 4.

FIG. 6 is a cross-sectional view of the well borehole of FIG. 5 following the drilling out of the shoe.

FIG. 7 is fragmentary cross-sectional illustration of the well borehole of FIG. 6 after positioning a shaped charge within the overlap between the expandable tubular member and the preexisting wellbore casing.

FIG. 8 is a cross-sectional illustration of the well borehole of FIG. 7 after detonating the shaped charge to plastically deform and radially expand the overlap between the expandable tubular member and the preexisting wellbore casing.

FIG. 9 is a fragmentary cross-sectional view of the placement and actuation of an expansion cone within the well borehole of FIG. 8 to form a mono-diameter wellbore casing.

FIG. 10 is a cross-sectional illustration of the well borehole of FIG. 9 following the formation of a mono-diameter wellbore casing.

FIG. 11 is a cross-sectional illustration of the well borehole of FIG. 10 following the repeated operation of the methods of FIGS. 1-10 in order to form a mono-diameter wellbore casing including a plurality of overlapping wellbore casings.

FIG. 12 is a fragmentary cross-sectional illustration of the placement of an alternative embodiment of an apparatus for forming a mono-diameter wellbore casing into the well borehole of FIG. 8.

FIG. 13 is a cross-sectional illustration of the well borehole of FIG. 12 following the formation of a mono-diameter wellbore casing.

FIG. 14 is a fragmentary cross-sectional illustration of the placement of an alternative embodiment of an apparatus for forming a mono-diameter wellbore casing into the well borehole of FIG. 8.

FIG. 15 is a fragmentary cross-sectional illustration of the well borehole of FIG. 14 during the injection of pressurized fluids into the well borehole.

FIG. 16 is a fragmentary cross-sectional illustration of the well borehole of FIG. 15 during the formation of the mono-diameter wellbore casing.

FIG. 17 is a fragmentary cross-sectional illustration of the well borehole of FIG. 16 following the formation of the mono-diameter wellbore casing.

Detailed Description of the Illustrative Embodiments

Referring initially to FIGS. 1-10, an embodiment of an apparatus and method for forming a mono-diameter wellbore casing within a subterranean formation will now be described. As illustrated in Fig. 1, a wellbore 100 is positioned in a subterranean formation 105. The wellbore 100 includes a pre-existing cased section 110 having pre-existing wellbore casing 115 and an annular outer layer 120 of a fluidic sealing material such as, for example, cement. The wellbore 100 may be positioned in any orientation from vertical to horizontal. In several alternative embodiments, the pre-existing cased section 110 does not include the annular outer layer 120.

In order to extend the wellbore 100 into the subterranean formation 105, a drill string 125 is used in a well known manner to drill out material from the subterranean formation 105 to form a new wellbore section 130.

As illustrated in FIG. 2, an apparatus 200 for forming a wellbore casing in a subterranean formation is then positioned in the new section 130 of the wellbore 100 that includes tubular expansion cone 205 having a fluid passage 205a that supports an expandable tubular member 210 that includes a lower portion 210a, an intermediate portion 210b, an upper portion 210c, and an upper end portion 210d.

The tubular expansion cone 205 may be any number of conventional commercially available expansion cones. In several alternative embodiments, the tubular expansion cone 205 may be controllably expandable in the radial direction, for example, as disclosed in U.S. patent nos. 5,348,095, and/or 6,012,523, the disclosures of which are incorporated herein by reference.

The expandable tubular member 210 may be fabricated from any number of conventional commercially available materials such as, for example, Oilfield Country

Tubular Goods (OCTG), 13 chromium steel tubing/casing, or plastic tubing/casing. In an exemplary embodiment, the expandable tubular member 210 is fabricated from OCTG in order to maximize strength after expansion. In several alternative embodiments, the expandable tubular member 210 may be solid and/or slotted. In an exemplary embodiment, the length of the expandable tubular member 210 is limited to minimize the possibility of buckling. For typical expandable tubular member 210 materials, the length of the expandable tubular member 210 is preferably limited to between about 40 to 20,000 feet in length.

The lower portion 210a of the expandable tubular member 210 preferably has a larger inside diameter than the upper portion 210c of the expandable tubular member. In an exemplary embodiment, the wall thickness of the intermediate portion 210b of the expandable tubular member 210 is less than the wall thickness of the upper portion 210c of the expandable tubular member in order to facilitate the initiation of the radial expansion process. In an exemplary embodiment, the upper end portion 210d of the expandable tubular member 210 is slotted, perforated, or otherwise modified to catch or slow down the expansion cone 205 when it completes the extrusion of expandable tubular member 210.

A shoe 215 is coupled to the lower portion 210a of the expandable tubular member. The shoe 215 includes a valveable fluid passage 220 that is preferably adapted to receive a plug, dart, or other similar element for controllably sealing the fluid passage 220. In this manner, the fluid passage 220 may be optimally sealed off by introducing a plug, dart and/or ball sealing elements into the fluid passage 240.

The shoe 215 may be any number of conventional commercially available shoes such as, for example, Super Seal II float shoe, Super Seal II Down-Jet float shoe or a guide shoe with a sealing sleeve for a latch down plug modified in accordance with the teachings of the present disclosure. In an exemplary embodiment, the shoe 215 is an aluminum down-jet guide shoe with a sealing sleeve for a latch-down plug available from Halliburton Energy Services in Dallas, TX, modified in accordance with the teachings of the present disclosure, in order to optimally guide the expandable tubular member 210 in the wellbore, optimally provide an adequate seal between the interior and exterior diameters of the overlapping joint between the tubular members, and to optimally allow the complete drill out of the shoe and plug after the completion of the cementing and expansion operations.

In an exemplary embodiment, the shoe 215 further includes one or more through and side outlet ports in fluidic communication with the fluid passage 220. In this

manner, the shoe 215 optimally injects hardenable fluidic sealing material into the region outside the shoe 215 and expandable tubular member 210.

A support member 225 having fluid passages 225a and 225b is coupled to the expansion cone 205 for supporting the apparatus 200. The fluid passage 225a is preferably fluidicly coupled to the fluid passage 205a. In this manner, fluidic materials may be conveyed to and from a region 230 below the expansion cone 205 and above the bottom of the shoe 215. The fluid passage 225b is preferably fluidicly coupled to the fluid passage 225a and includes a conventional control valve. In this manner, during placement of the apparatus 200 within the wellbore 100, surge pressures can be relieved by the fluid passage 225b. In an exemplary embodiment, the support member 225 further includes one or more conventional centralizers (not illustrated) to help stabilize the apparatus 200.

During placement of the apparatus 200 within the wellbore 100, the fluid passage 225a is preferably selected to transport materials such as, for example, drilling mud or formation fluids at flow rates and pressures ranging from about 0 to 3,000 gallons/minute and 0 to 9,000 psi in order to minimize drag on the tubular member being run and to minimize surge pressures exerted on the wellbore 130 which could cause a loss of wellbore fluids and lead to hole collapse. During placement of the apparatus 200 within the wellbore 100, the fluid passage 225b is preferably selected to convey fluidic materials at flow rates and pressures ranging from about 0 to 3,000 gallons/minute and 0 to 9,000 psi in order to reduce the drag on the apparatus 200 during insertion into the new section 130 of the wellbore 100 and to minimize surge pressures on the new wellbore section 130.

A lower cup seal 235 is coupled to and supported by the support member 225. The lower cup seal 235 prevents foreign materials from entering the interior region of the expandable tubular member 210 adjacent to the expansion cone 205. The lower cup seal 235 may be any number of conventional commercially available cup seals such as, for example, TP cups, or Selective Injection Packer (SIP) cups modified in accordance with the teachings of the present disclosure. In an exemplary embodiment, the lower cup seal 235 is a SIP cup seal, available from Halliburton Energy Services in Dallas, TX in order to optimally block foreign material and contain a body of lubricant.

The upper cup seal 240 is coupled to and supported by the support member 225. The upper cup seal 240 prevents foreign materials from entering the interior region of the expandable tubular member 210. The upper cup seal 240 may be any number of conventional commercially available cup seals such as, for example, TP cups or SIP cups modified in accordance with the teachings of the present disclosure. In an

exemplary embodiment, the upper cup seal 240 is a SIP cup, available from Halliburton Energy Services in Dallas, TX in order to optimally block the entry of foreign materials and contain a body of lubricant.

One or more sealing members 245 are coupled to and supported by the exterior surface of the upper end portion 210d of the expandable tubular member 210. The seal members 245 preferably provide an overlapping joint between the lower end portion 115a of the casing 115 and the portion 260 of the expandable tubular member 210 to be fluidicly sealed. The sealing members 245 may be any number of conventional commercially available seals such as, for example, lead, rubber, Teflon, or epoxy seals modified in accordance with the teachings of the present disclosure. In an exemplary embodiment, the sealing members 245 are molded from Stratalock epoxy available from Halliburton Energy Services in Dallas, TX in order to optimally provide a load bearing interference fit between the upper end portion 210d of the expandable tubular member 210 and the lower end portion 115a of the existing casing 115.

In an exemplary embodiment, the sealing members 245 are selected to optimally provide a sufficient frictional force to support the expanded tubular member 210 from the existing casing 115. In an exemplary embodiment, the frictional force optimally provided by the sealing members 245 ranges from about 1,000 to 1,000,000 lbf in order to optimally support the expanded tubular member 210.

In an exemplary embodiment, a quantity of lubricant 250 is provided in the annular region above the expansion cone 205 within the interior of the expandable tubular member 210. In this manner, the extrusion of the expandable tubular member 210 off of the expansion cone 205 is facilitated. The lubricant 250 may be any number of conventional commercially available lubricants such as, for example, Lubriplate, chlorine based lubricants, oil based lubricants or Climax 1500 Antisieze (3100). In an exemplary embodiment, the lubricant 250 is Climax 1500 Antisieze (3100) available from Climax Lubricants and Equipment Co. in Houston, TX in order to optimally provide optimum lubrication to facilitate the expansion process.

In an exemplary embodiment, the support member 225 is thoroughly cleaned prior to assembly to the remaining portions of the apparatus 200. In this manner, the introduction of foreign material into the apparatus 200 is minimized. This minimizes the possibility of foreign material clogging the various flow passages and valves of the apparatus 200.

In an exemplary embodiment, before or after positioning the apparatus 200 within the new section 130 of the wellbore 100, a couple of wellbore volumes are circulated in

order to ensure that no foreign materials are located within the wellbore 100 that might clog up the various flow passages and valves of the apparatus 200 and to ensure that no foreign material interferes with the expansion process.

As illustrated in FIG. 2, in an exemplary embodiment, during placement of the apparatus 200 within the wellbore 100, fluidic materials 255 within the wellbore that are displaced by the apparatus are conveyed through the fluid passages 220, 205a, 225a, and 225b. In this manner, surge pressures created by the placement of the apparatus within the wellbore 100 are reduced.

As illustrated in FIG. 3, the fluid passage 225b is then closed and a hardenable fluidic sealing material 305 is then pumped from a surface location into the fluid passages 225a and 205a. The material 305 then passes from the fluid passage 205a into the interior region 230 of the expandable tubular member 210 below the expansion cone 205. The material 305 then passes from the interior region 230 into the fluid passage 220. The material 305 then exits the apparatus 200 and fills an annular region 310 between the exterior of the expandable tubular member 210 and the interior wall of the new section 130 of the wellbore 100. Continued pumping of the material 305 causes the material 305 to fill up at least a portion of the annular region 310.

The material 305 is preferably pumped into the annular region 310 at pressures and flow rates ranging, for example, from about 0 to 5000 psi and 0 to 1,500 gallons/min, respectively. The optimum flow rate and operating pressures vary as a function of the casing and wellbore sizes, wellbore section length, available pumping equipment, and fluid properties of the fluidic material being pumped. The optimum flow rate and operating pressure are preferably determined using conventional empirical methods.

The hardenable fluidic sealing material 305 may be any number of conventional commercially available hardenable fluidic sealing materials such as, for example, slag mix, cement or epoxy. In an exemplary embodiment, the hardenable fluidic sealing material 305 is a blended cement prepared specifically for the particular well section being drilled from Halliburton Energy Services in Dallas, TX in order to provide optimal support for expandable tubular member 210 while also maintaining optimum flow characteristics so as to minimize difficulties during the displacement of cement in the annular region 315. The optimum blend of the blended cement is preferably determined using conventional empirical methods. In several alternative embodiments, the hardenable fluidic sealing material 305 is compressible before, during, or after curing.

The annular region 310 preferably is filled with the material 305 in sufficient quantities to ensure that, upon radial expansion of the expandable tubular member 210, the annular region 310 of the new section 130 of the wellbore 100 will be filled with the material 305.

In an alternative embodiment, the injection of the material 305 into the annular region 310 is omitted.

As illustrated in FIG. 4, once the annular region 310 has been adequately filled with the material 305, a plug 405, or other similar device, is introduced into the fluid passage 220, thereby fluidicly isolating the interior region 230 from the annular region 310. In an exemplary embodiment, a non-hardenable fluidic material 315 is then pumped into the interior region 230 causing the interior region to pressurize. In this manner, the interior region 230 of the expanded tubular member 210 will not contain significant amounts of cured material 305. This also reduces and simplifies the cost of the entire process. Alternatively, the material 305 may be used during this phase of the process.

Once the interior region 230 becomes sufficiently pressurized, the expandable tubular member 210 is preferably plastically deformed, radially expanded, and extruded off of the expansion cone 205. During the extrusion process, the expansion cone 205 may be raised out of the expanded portion of the expandable tubular member 210. In an exemplary embodiment, during the extrusion process, the expansion cone 205 is raised at approximately the same rate as the expandable tubular member 210 is expanded in order to keep the expandable tubular member 210 stationary relative to the new wellbore section 130. In an alternative preferred embodiment, the extrusion process is commenced with the expandable tubular member 210 positioned above the bottom of the new wellbore section 130, keeping the expansion cone 205 stationary, and allowing the expandable tubular member 210 to extrude off of the expansion cone 205 and into the new wellbore section 130 under the force of gravity and the operating pressure of the interior region 230.

The plug 405 is preferably placed into the fluid passage 220 by introducing the plug 405 into the fluid passage 225a at a surface location in a conventional manner. The plug 405 preferably acts to fluidicly isolate the hardenable fluidic sealing material 305 from the non hardenable fluidic material 315.

The plug 405 may be any number of conventional commercially available devices from plugging a fluid passage such as, for example, Multiple Stage Cementer (MSC) latch-down plug, Omega latch-down plug or three-wiper latch-down plug modified in accordance with the teachings of the present disclosure. In an exemplary embodiment,

the plug 405 is a MSC latch-down plug available from Halliburton Energy Services in Dallas, TX.

After placement of the plug 405 in the fluid passage 220, the non hardenable fluidic material 315 is preferably pumped into the interior region 310 at pressures and flow rates ranging, for example, from approximately 400 to 10,000 psi and 30 to 4,000 gallons/min. In this manner, the amount of hardenable fluidic sealing material within the interior 230 of the expandable tubular member 210 is minimized. In an exemplary embodiment, after placement of the plug 405 in the fluid passage 220, the non hardenable material 315 is preferably pumped into the interior region 230 at pressures and flow rates ranging from approximately 500 to 9,000 psi and 40 to 3,000 gallons/min in order to maximize the extrusion speed.

In an exemplary embodiment, the apparatus 200 is adapted to minimize tensile, burst, and friction effects upon the expandable tubular member 210 during the expansion process. These effects will be depend upon the geometry of the expansion cone 205, the material composition of the expandable tubular member 210 and expansion cone 205, the inner diameter of the expandable tubular member, the wall thickness of the expandable tubular member, the type of lubricant, and the yield strength of the expandable tubular member. In general, the thicker the wall thickness, the smaller the inner diameter, and the greater the yield strength of the expandable tubular member 210, then the greater the operating pressures required to extrude the expandable tubular member 210 off of the expansion cone 205.

In an exemplary embodiment, the extrusion of the expandable tubular member off of the expansion cone 205 will begin when the pressure of the interior region 230 reaches, for example, approximately 500 to 9,000 psi.

During the extrusion process, the expansion cone 205 may be raised out of the expanded portion of the expandable tubular member 210 at rates ranging, for example, from about 0 to 5 ft/sec. In an exemplary embodiment, during the extrusion process, the expansion cone 205 is raised out of the expanded portion of the expandable tubular member 210 at rates ranging from about 0 to 2 ft/sec in order to minimize the time required for the expansion process while also permitting easy control of the expansion process.

When the upper end portion 210d of the expandable tubular member 210 is extruded off of the expansion cone 205, the outer surface of the upper end portion 210d of the expandable tubular member 210 will preferably contact the interior surface of the lower end portion 115a of the wellbore casing 115 to form an fluid tight overlapping joint. The contact pressure of the overlapping joint may range, for

example, from approximately 50 to 20,000 psi. In an exemplary embodiment, the contact pressure of the overlapping joint ranges from approximately 400 to 10,000 psi in order to provide optimum pressure to activate the annular sealing members 245 and optimally provide resistance to axial motion to accommodate typical tensile and compressive loads.

The overlapping joint between the pre-existing wellbore casing 115 and the radially expanded expandable tubular member 210 preferably provides a gaseous and fluidic seal. In a particularly preferred embodiment, the sealing members 245 optimally provide a fluidic and gaseous seal in the overlapping joint. In an alternative embodiment, the sealing members 245 are omitted.

In an exemplary embodiment, the operating pressure and flow rate of the non-hardenable fluidic material 315 is controllably ramped down when the expansion cone 205 reaches the upper end portion 210d of the expandable tubular member 210. In this manner, the sudden release of pressure caused by the complete extrusion of the expandable tubular member 210 off of the expansion cone 205 can be minimized. In an exemplary embodiment, the operating pressure is reduced in a substantially linear fashion from 100% to about 10% during the end of the extrusion process beginning when the expansion cone 205 is within about 5 feet from completion of the extrusion process.

Alternatively, or in combination, a shock absorber is provided in the support member 225 in order to absorb the shock caused by the sudden release of pressure. The shock absorber may, for example, be any conventional commercially available shock absorber adapted for use in wellbore operations.

Alternatively, or in combination, an expansion cone catching structure is provided in the upper end portion 210d of the expandable tubular member 210 in order to catch or at least decelerate the expansion cone 205.

Once the extrusion process is completed, the expansion cone 205 is removed from the wellbore 100. In an exemplary embodiment, either before or after the removal of the expansion cone 205, the integrity of the fluidic seal of the overlapping joint between the upper end portion 210d of the expandable tubular member 210 and the lower end portion 115a of the preexisting wellbore casing 115 is tested using conventional methods.

In an exemplary embodiment, if the fluidic seal of the overlapping joint between the upper end portion 210d of the expandable tubular member 210 and the lower end portion 115a of the casing 115 is satisfactory, then any uncured portion of the material 305 within the expanded expandable tubular member 210 is then removed in a

conventional manner such as, for example, circulating the uncured material out of the interior of the expanded tubular member 210. The expansion cone 205 is then pulled out of the wellbore section 130 and a drill bit or mill is used in combination with a conventional drilling assembly 505 to drill out any hardened material 305 within the expandable tubular member 210. In an exemplary embodiment, the material 305 within the annular region 310 is then allowed to fully cure.

As illustrated in Fig. 5, preferably any remaining cured material 305 within the interior of the expanded tubular member 210 is then removed in a conventional manner using a conventional drill string 505. The resulting new section of casing 510 preferably includes the expanded tubular member 210 and an outer annular layer 515 of the cured material 305.

As illustrated in FIG. 6, the bottom portion of the apparatus 200 including the shoe 215 and dart 405 may then be removed by drilling out the shoe 215 and dart 405 using conventional drilling methods.

As illustrated in FIG. 7, an apparatus 600 for radially expanding and plastically deforming the overlap between the lower portion of the preexisting wellbore casing 115 and the upper portion 210d of the expandable tubular member 210 may then be positioned within the borehole 110 that includes a shaped charge 605 that is coupled to an end of a tubular member 610. In an exemplary embodiment, the shaped charge 605 is positioned within the overlap between the lower portion of the preexisting wellbore casing 115 and the upper portion 210d of the expandable tubular member 210.

As illustrated in FIG. 8, the shaped charge 605 is then detonated in a conventional manner to plastically deform and radially expand the overlap between the lower portion of the preexisting wellbore casing 115 and the upper portion 210d of the expanded tubular member 210. As a result, the inside diameter of the upper portion 210d of the expanded tubular member 210 is substantially equal to the inside diameter of the portion of the preexisting wellbore casing 115 that does not overlap with the upper portion of the expanded tubular member. In several alternative embodiments, one or more conventional devices for generating impulsive radially directed forces may be substituted for, or used in combination with, the shaped charge 605.

As illustrated in FIG. 9, an apparatus 700 for forming a mono-diameter wellbore casing is then positioned within the wellbore casing 115 proximate upper end 210d of the expandable tubular member 210 that includes a tubular expansion cone 705 coupled to an end of a tubular support member 710. In an exemplary embodiment, the outside diameter of the tubular expansion cone 705 is substantially equal to the inside

diameter of the wellbore casing 115. The tubular expansion cone 705 and the tubular support member 710 together define a fluid passage 715 for conveying fluidic materials 720 out of the wellbore 100 that are displaced by the placement and operation of the tubular expansion cone 705.

The tubular expansion cone 705 is then driven downward using the support member 710 in order to radially expand and plastically deform the portion of the expandable tubular member 210 that does not overlap with the wellbore casing 115. In this manner, as illustrated in FIG. 10, a mono-diameter wellbore casing is formed that includes the overlapping wellbore casings 115 and 210. In several alternative embodiments, the secondary radial expansion process illustrated in FIGS. 9 and 10 is performed before, during, or after the material 515 fully cures. In several alternative embodiments, a conventional expansion device including rollers may be substituted for, or used in combination with, the apparatus 700. In an exemplary embodiment, the downward displacement of the tubular expansion cone 705 also at least partially radially expands and plastically deforms the portions of the pre-existing wellbore casing 115 and the upper portion 210d of the expandable tubular member that overlap with one another,

More generally, as illustrated in FIG. 11, the method of FIGS. 1-10 is repeatedly performed in order to provide a mono-diameter wellbore casing that includes overlapping wellbore casings 115 and 210a-210e. The wellbore casings 115, and 210a-210e preferably include outer annular layers of fluidic sealing material. In this manner, a mono-diameter wellbore casing may be formed within the subterranean formation that extends for tens of thousands of feet. More generally still, the teachings of FIGS. 1-11 may be used to form a mono-diameter wellbore casing, a pipeline, a structural support, or a tunnel within a subterranean formation at any orientation from the vertical to the horizontal.

In an exemplary embodiment, the formation of the mono-diameter wellbore casing, as illustrated in FIGS. 1-11, is further provided as disclosed in one or more of the following: (1) U.S. patent application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, (3) U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, (4) U.S. patent application serial no. 09/440,338, attorney docket no. 25791.9.02, filed on 11/15/1999, (5) PCT patent application serial no. PCT/US01/04753, attorney docket no. 25791.10.02, filed on 2/14/2001, (6) U.S. patent application serial no. 09/523,460, attorney docket no. 25791.11.02, filed on 3/10/2000, (7) U.S. patent application serial

no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, (8) U.S. patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on 2/24/2000, (9) U.S. patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, (10) U.S. patent application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, (11) PCT patent application serial no. PCT/US00/18635, attorney docket no. 25791.25.02, filed on 7/9/2000, (12) PCT patent application serial no. PCT/US00/30022, attorney docket no. 25791.27.02, filed on 10/31/2000, (13) U.S. patent application serial no. 09/679,907, attorney docket no. 25791.34.02, filed on 10/5/2000, (14) PCT patent application serial no. PCT/US00/27645, attorney docket no. 25791.36.02, filed on 10/5/2000, (15) U.S. patent application serial no. 09/679,906, attorney docket no. 25791.37.02, filed on 10/5/2000, (16) PCT patent application serial no. PCT/US01/19014, attorney docket no. 25791.38.02, filed on 6/12/2001, (17) PCT patent application serial no. PCT/US01/41446, attorney docket no. 25791.45.02, filed on 7/28/2001, (18) PCT patent application serial no. PCT/US01/23815, attorney docket no. 25791.46.02, filed on 7/27/2001, (19) PCT patent application serial no. PCT/US01/28960, attorney docket no. 25791.47.02, filed on 9/17/2001, (20) U.S. provisional patent application serial no. 60/237,334, attorney docket no. 25791.48, filed on 10/2/2000, (21) U.S. provisional patent application serial no. 60/270,007, attorney docket no. 25791.50, filed on 2/20/2001; (22) U.S. provisional patent application serial no. 60/262,434, attorney docket no. 25791.51, filed on 1/17/2001; (23) U.S, provisional patent application serial no. 60/259,486, attorney docket no. 25791.52, filed on 1/3/2001; (24) U.S. provisional patent application serial no. 60/303,740, attorney docket no. 25791.61, filed on 7/6/2001; (25) U.S. provisional patent application serial no. 60/313,453, attorney docket no. 25791.59, filed on 8/20/2001; (26) PCT patent application serial no. PCT/US02/24399, attorney docket no. 25791.59.02, filed on 8/1/02, (27) U.S. provisional patent application serial no. 60/317,985, attorney docket no. 25791.67, filed on 9/6/2001, (28) U.S. provisional patent application serial no. 60/318,021, attorney docket no. 25791.58, filed on 9/7/2001, (29) PCT patent application serial no. PCT/US________________, attorney docket no. 25791.58.02 filed on 8/13/02, (30) U.S. provisional patent application serial no. 60/318,386, attorney docket no. 25791.67.02, filed on 9/10/2001 and (31) PCT patent application serial no. PCT/US________________, attorney docket no. 25791.67.03, filed on 8/14/02, the disclosures of which are incorporated herein by reference.

In an alternative embodiment, the fluid passage 220 in the shoe 215 is omitted. In this manner, the pressurization of the region 230 is simplified. In an alternative

embodiment, the annular body 515 of the fluidic sealing material is formed using conventional methods of injecting a hardenable fluidic sealing material into the annular region 310.

In an alternative embodiment of the apparatus 700, the fluid passage 715 is omitted. In this manner, in an exemplary embodiment, the region of the wellbore 100 below the expansion cone 705 is pressurized and one or more regions of the subterranean formation 105 are fractured to enhance the oil and/or gas recovery process.

Referring to FIGS. 12-13, in an alternative embodiment, an apparatus 800 for forming a mono-diameter wellbore casing is positioned within the wellbore casing 115 that includes a tubular expansion cone 805 that defines a fluid passage 805a that is coupled to a support member 810.

The tubular expansion cone 805 preferably further includes a conical outer surface 805b for radially expanding and plastically deforming the portion of the expandable tubular member 210 that does not overlap with the wellbore casing 115. In an exemplary embodiment, the outside diameter of the tubular expansion cone 805 is substantially equal to the inside diameter of the portion of the pre-existing wellbore casing 115 that does not overlap with the expandable tubular member 210.

The support member 810 is coupled to a slip joint 815, and the slip joint is coupled to a support member 820. As will be recognized by persons having ordinary skill in the art, a slip joint permits relative movement between objects. Thus, in this manner, the expansion cone 805 and support member 810 may be displaced in the longitudinal direction relative to the support member 820. In an exemplary embodiment, the slip joint 810 permits the expansion cone 805 and support member 810 to be displaced in the longitudinal direction relative to the support member 820 for a distance greater than or equal to the axial length of the expandable tubular member 210. In this manner, the expansion cone 805 may be used to plastically deform and radially expand the portion of the expandable tubular member 210 that does not overlap with the pre-existing wellbore casing 115 without having to reposition the support member 820.

The slip joint 815 may be any number of conventional commercially available slip joints that include a fluid passage for conveying fluidic materials through the slip joint. In an exemplary embodiment, the slip joint 815 is a pumper sub commercially available from Bowen Oil Tools in order to optimally provide elongation of the drill string.

The support member 810, slip joint 815, and support member 820 further include fluid passages 810a, 815a, and 820a, respectively, that are fluidicly coupled to the fluid

passage 805a. During operation, the fluid passages 805a, 810a, 815a, and 820a preferably permit fluidic materials 825 displaced by the expansion cone 805 to be conveyed to a location above the apparatus 800. In this manner, operating pressures within the subterranean formation 105 below the expansion cone are minimized.

The support member 820 further preferably includes a fluid passage 820b that permits fluidic materials 830 to be conveyed into an annular region 835 surrounding the support member 810, the slip joint 815, and the support member 820 and bounded by the expansion cone 805 and a conventional packer 840 that is coupled to the support member 820. In this manner, the annular region 835 may be pressurized by the injection of the fluids 830 thereby causing the expansion cone 805 to be displaced in the longitudinal direction relative to the support member 820 to thereby plastically deform and radially expand the portion of the expandable tubular member 210 that does not overlap with the pre-existing wellbore casing 115.

During operation, as illustrated in FIG. 10, in an exemplary embodiment, the apparatus 800 is positioned within the preexisting casing 115 with the bottom surface of the expansion cone 805 proximate the top of the expandable tubular member 210. During placement of the apparatus 800 within the preexisting casing 115, fluidic materials 825 within the casing are conveyed out of the casing through the fluid passages 805a, 810a, 815a, and 820a. In this manner, surge pressures within the wellbore 100 are minimized.

The packer 840 is then operated in a well-known manner to fluidicly isolate the annular region 835 from the annular region above the packer. The fluidic material 830 is then injected into the annular region 835 using the fluid passage 820b. Continued injection of the fluidic material 830 into the annular region 835 preferably pressurizes the annular region and thereby causes the expansion cone 805 and support member 810 to be displaced in the longitudinal direction relative to the support member 820.

As illustrated in FIG. 13, in an exemplary embodiment, the longitudinal displacement of the expansion cone 805 in turn plastically deforms and radially expands the portion of the expandable tubular member 210 that does not overlap the pre-existing wellbore casing 115. In this manner, a mono-diameter wellbore casing is formed that includes the overlapping wellbore casings 115 and 210. The apparatus 800 may then be removed from the wellbore 100 by releasing the packer 840 from engagement with the wellbore casing 115, and lifting the apparatus 800 out of the wellbore 100. In an exemplary embodiment, the downward longitudinal displacement of the expansion cone 805 also at least partially radially expands and plastically

deforms the portions of the pre-existing wellbore casing 115 and the upper portion 210d of the expandable tubular member 210 that overlap with one another.

In an alternative embodiment of the apparatus 800, the fluid passage 820b is provided within the packer 840 in order to enhance the operation of the apparatus 800.

In an alternative embodiment of the apparatus 800, the fluid passages 805a, 810a, 815a, and 820a are omitted. In this manner, in an exemplary embodiment, the region of the wellbore 100 below the expansion cone 805 is pressurized and one or more regions of the subterranean formation 105 are fractured to enhance the oil and/or gas recovery process.

Referring to FIGS. 14-17, in an alternative embodiment, an apparatus 900 is positioned within the wellbore casing 115 that includes an expansion cone 905 having a fluid passage 905a that is releasably coupled to a releasable coupling 910 having fluid passage 910a.

The fluid passage 905a is preferably adapted to receive a conventional ball, plug, or other similar device for sealing off the fluid passage. The expansion cone 905 further includes a conical outer surface 905b for radially expanding and plastically deforming the portion of the expandable tubular member 210 that does not overlap the pre-existing wellbore casing 115. In an exemplary embodiment, the outside diameter of the expansion cone 905 is substantially equal to the inside diameter of the portion of the pre-existing wellbore casing 115 that does not overlap with the upper end 210d of the expandable tubular member 210.

The releasable coupling 910 may be any number of conventional commercially available releasable couplings that include a fluid passage for conveying fluidic materials through the releasable coupling. In an exemplary embodiment, the releasable coupling 910 is a safety joint commercially available from Halliburton in order to optimally release the expansion cone 905 from the support member 915 at a predetermined location.

A support member 915 is coupled to the releasable coupling 910 that includes a fluid passage 915a. The fluid passages 905a, 910a and 915a are fluidicly coupled. In this manner, fluidic materials may be conveyed into and out of the wellbore 100.

A packer 920 is movably and sealingly coupled to the support member 915. The packer may be any number of conventional packers. In an exemplary embodiment, the packer 920 is a commercially available burst preventer (BOP) in order to optimally provide a sealing member.

During operation, as illustrated in FIG. 14, in an exemplary embodiment, the apparatus 900 is positioned within the preexisting casing 115 with the bottom surface

of the expansion cone 905 proximate the top of the expandable tubular member 210. During placement of the apparatus 900 within the preexisting casing 115, fluidic materials 925 within the casing are conveyed out of the casing through the fluid passages 905a, 910a, and 915a. In this manner, surge pressures within the wellbore 100 are minimized. The packer 920 is then operated in a well-known manner to fluidicly isolate a region 930 within the casing 115 between the expansion cone 905 and the packer 920 from the region above the packer.

In an exemplary embodiment, as illustrated in FIG. 15, the releasable coupling 910 is then released from engagement with the expansion cone 905 and the support member 915 is moved away from the expansion cone. A fluidic material 935 may then be injected into the region 930 through the fluid passages 910a and 915a. The fluidic material 935 may then flow into the region of the wellbore 100 below the expansion cone 905 through the valveable passage 905b. Continued injection of the fluidic material 935 may thereby pressurize and fracture regions of the formation 105 below the expandable tubular member 210. In this manner, the recovery of oil and/or gas from the formation 105 may be enhanced.

In an exemplary embodiment, as illustrated in FIG. 16, a plug, ball, or other similar valve device 940 may then be positioned in the valveable passage 905a by introducing the valve device into the fluidic material 935. In this manner, the region 930 may be fluidicly isolated from the region below the expansion cone 905. Continued injection of the fluidic material 935 may then pressurize the region 930 thereby causing the expansion cone 905 to be displaced in the longitudinal direction.

In an exemplary embodiment, as illustrated in FIG. 17, the longitudinal displacement of the expansion cone 905 plastically deforms and radially expands the portion of the expandable tubular 210 that does not overlap with the pre-existing wellbore casing 115. In this manner, a mono-diameter wellbore casing is formed that includes the pre-existing wellbore casing 115 and the expandable tubular member 210. Upon completing the radial expansion process, the support member 915 may be moved toward the expansion cone 905 and the expansion cone may be re-coupled to the releasable coupling device 910. The packer 920 may then be decoupled from the wellbore casing 115, and the expansion cone 905 and the remainder of the apparatus 900 may then be removed from the wellbore 100. In an exemplary embodiment, the downward longitudinal displacement of the expansion cone 905 also at least partially plastically deforms and radially expands the portions of the pre-existing wellbore casing 115 and the upper portion 210d of the expandable tubular member 210 that overlap with one another.

In an exemplary embodiment, the displacement of the expansion cone 905 also pressurizes the region within the expandable tubular member 210 below the expansion cone. In this manner, the subterranean formation surrounding the expandable tubular member 210 may be elastically or plastically compressed thereby enhancing the structural properties of the formation.

A method of creating a mono-diameter wellbore casing in a borehole located in a subterranean formation including a preexisting wellbore casing has also been described that includes installing a tubular liner and a first expansion cone in the borehole, injecting a fluidic material into the borehole, pressurizing a portion of an interior region of the tubular liner below the first expansion cone, radially expanding at least a portion of the tubular liner in the borehole by extruding at least a portion of the tubular liner off of the first expansion cone, radially expanding an overlap between the preexisting wellbore casing and the tubular liner, and radially expanding the portion of the tubular liner that does not overlap with the preexisting wellbore casing using a second expansion cone. In an exemplary embodiment, radially expanding the overlap between the preexisting wellbore casing and the tubular liner includes impulsively applying outwardly directed radial forces to the interior of the overlap between the preexisting wellbore casing and the tubular liner. In an exemplary embodiment, impulsively applying outwardly directed radial forces to the interior of the overlap between the preexisting wellbore casing and the tubular liner includes detonating a shaped charge within the overlap between the preexisting wellbore casing and the tubular liner. In an exemplary embodiment, radially expanding the overlap between the preexisting wellbore casing and the tubular liner further includes displacing the second expansion cone in a longitudinal direction, and permitting fluidic materials displaced by the second expansion cone to be removed. In an exemplary embodiment, displacing the second expansion cone in a longitudinal direction includes applying fluid pressure to the second expansion cone. In an exemplary embodiment, radially expanding the overlap between the tubular liner and the preexisting wellbore casing using the second expansion cone further includes displacing the second expansion cone in a longitudinal direction, and compressing at least a portion of the subterranean formation using fluid pressure. In an exemplary embodiment, displacing the second expansion cone in a longitudinal direction includes applying fluid pressure to the second expansion cone. In an exemplary embodiment, radially expanding the portion of the tubular liner that does not overlap with the preexisting wellbore casing using the second expansion cone includes displacing the second expansion cone in a longitudinal direction, and permitting fluidic materials displaced by the second expansion cone to be removed. In

an exemplary embodiment, displacing the second expansion cone in the longitudinal direction includes applying fluid pressure to the second expansion cone. In an exemplary embodiment, radially expanding the portion of the tubular liner that does not overlap with the preexisting wellbore casing using the second expansion cone includes displacing the second expansion cone in a longitudinal direction, and compressing at least a portion of the subterranean formation using fluid pressure. In an exemplary embodiment, displacing the second expansion cone in the longitudinal direction includes applying fluid pressure to the second expansion cone. In an exemplary embodiment, the method further includes injecting a hardenable fluidic sealing material into an annulus between the tubular liner and the borehole.

A system for creating a mono-diameter wellbore casing in a borehole located in a subterranean formation including a preexisting wellbore casing has also been described that includes means for installing a tubular liner and a first expansion cone in the borehole, means for injecting a fluidic material into the borehole, means for pressurizing a portion of an interior region of the tubular liner below the first expansion cone, means for radially expanding at least a portion of the tubular liner in the borehole by extruding at least a portion of the tubular liner off of the first expansion cone, means for radially expanding an overlap between the preexisting wellbore casing and the tubular liner, and means for radially expanding the portion of the tubular liner that does not overlap with the preexisting wellbore casing using a second expansion cone. In an exemplary embodiment, the means for radially expanding the overlap between the preexisting wellbore casing and the tubular liner includes means for impulsively applying outwardly directed radial forces to the interior of the overlap between the preexisting wellbore casing and the tubular liner. In an exemplary embodiment, the means for impulsively applying outwardly directed radial forces to the interior of the overlap between the preexisting wellbore casing and the tubular liner includes means for detonating a shaped charge within the overlap between the preexisting wellbore casing and the tubular liner. In an exemplary embodiment, the means for radially expanding the overlap between the preexisting wellbore casing and the tubular liner further includes displacing the second expansion cone in a longitudinal direction, and permitting fluidic materials displaced by the second expansion cone to be removed. In an exemplary embodiment, the means for displacing the second expansion cone in a longitudinal direction includes means for applying fluid pressure to the second expansion cone. In an exemplary embodiment, the means for radially expanding the overlap between the tubular liner and the preexisting wellbore casing using the second expansion cone further includes means for displacing the second expansion cone in a

longitudinal direction, and means for compressing at least a portion of the subterranean formation using fluid pressure. In an exemplary embodiment, the means for displacing the second expansion cone in a longitudinal direction includes means for applying fluid pressure to the second expansion cone. In an exemplary embodiment, the means for radially expanding the portion of the tubular liner that does not overlap with the preexisting wellbore casing using the second expansion cone includes means for displacing the second expansion cone in a longitudinal direction, and means for permitting fluidic materials displaced by the second expansion cone to be removed. In an exemplary embodiment, the means for displacing the second expansion cone in the longitudinal direction includes means for applying fluid pressure to the second expansion cone. In an exemplary embodiment, the means for radially expanding the portion of the tubular liner that does not overlap with the preexisting wellbore casing using the second expansion cone includes means for displacing the second expansion cone in a longitudinal direction, and means for compressing at least a portion of the subterranean formation using fluid pressure. In an exemplary embodiment, the means for displacing the second expansion cone in the longitudinal direction includes means for applying fluid pressure to the second expansion cone. In an exemplary embodiment, the system further includes means for injecting a hardenable fluidic sealing material into an annulus between the tubular liner and the borehole.

A method of creating a tubular structure having a substantially constant inside diameter has also been described that includes installing a first tubular member and a first expansion cone within a second tubular member, injecting a fluidic material into the second tubular member, pressurizing a portion of an interior region of the first tubular member below the first expansion cone, radially expanding at least a portion of the first tubular member in the second tubular member by extruding at least a portion of the first tubular member off of the first expansion cone, radially expanding an overlap between the first and second tubular members, and radially expanding the portion of the first tubular member that does not overlap with the second tubular member using a second expansion cone. In an exemplary embodiment, radially expanding the overlap between the first and second tubular members includes impulsively applying outwardly directed radial forces to the interior of the overlap between the first and second tubular members. In an exemplary embodiment, impulsively applying outwardly directed radial forces to the interior of the overlap between the first and second tubular members includes detonating a shaped charge within the overlap between the first and second tubular members. In an exemplary embodiment, radially expanding the overlap between the first and second tubular members further includes displacing the second

expansion cone in a longitudinal direction, and permitting fluidic materials displaced by the second expansion cone to be removed. In an exemplary embodiment, displacing the second expansion cone in a longitudinal direction includes applying fluid pressure to the second expansion cone. In an exemplary embodiment, radially expanding the overlap between the first and second tubular members using the second expansion cone further includes displacing the second expansion cone in a longitudinal direction, and compressing at least a portion of the subterranean formation using fluid pressure. In an exemplary embodiment, displacing the second expansion cone in a longitudinal direction includes applying fluid pressure to the second expansion cone. In an exemplary embodiment, radially expanding the portion of the first tubular member that does not overlap with the second tubular member using the second expansion cone includes displacing the second expansion cone in a longitudinal direction, and permitting fluidic materials displaced by the second expansion cone to be removed. In an exemplary embodiment, displacing the second expansion cone in the longitudinal direction includes applying fluid pressure to the second expansion cone.

A system for creating a tubular structure having a substantially constant inside diameter has also been described that includes means for installing a first tubular member and a first expansion cone within a second tubular member, means for injecting a fluidic material into the second tubular member, means for pressurizing a portion of an interior region of the first tubular member below the first expansion cone, means for radially expanding at least a portion of the first tubular member in the second tubular member by extruding at least a portion of the first tubular member off of the first expansion cone, means for radially expanding an overlap between the first and second tubular members, and means for radially expanding the portion of the first tubular member that does not overlap with the second tubular member using a second expansion cone. In an exemplary embodiment, the means for radially expanding the overlap between the first and second tubular members includes means for impulsively applying outwardly directed radial forces to the interior of the overlap between the first and second tubular members. In an exemplary embodiment, the means for impulsively applying outwardly directed radial forces to the interior of the overlap between the first and second tubular members includes means for detonating a shaped charge within the overlap between the first and second tubular members. In an exemplary embodiment, the means for radially expanding the overlap between the first and second tubular members further includes means for displacing the second expansion cone in a longitudinal direction, and means for permitting fluidic materials displaced by the second expansion cone to be removed. In an exemplary embodiment, the means

for displacing the second expansion cone in a longitudinal direction includes means for applying fluid pressure to the second expansion cone. In an exemplary embodiment, the means for radially expanding the overlap between the first and second tubular members using the second expansion cone further includes means for displacing the second expansion cone in a longitudinal direction, and means for compressing at least a portion of the subterranean formation using fluid pressure. In an exemplary embodiment, the means for displacing the second expansion cone in a longitudinal direction includes means for applying fluid pressure to the second expansion cone. In an exemplary embodiment, the means for radially expanding the portion of the first tubular member that does not overlap with the second tubular member using the second expansion cone includes means for displacing the second expansion cone in a longitudinal direction, and means for permitting fluidic materials displaced by the second expansion cone to be removed. In an exemplary embodiment, the means for displacing the second expansion cone in the longitudinal direction includes means for applying fluid pressure to the second expansion cone.

An apparatus has also been described that includes a subterranean formation including a borehole, a wellbore casing coupled to the borehole, and a tubular liner overlappingly coupled to the wellbore casing, wherein the inside diameter of the portion of the wellbore casing that does not overlap with the tubular liner is substantially equal to the inside diameter of the tubular liner, and wherein the tubular liner is coupled to the wellbore casing by a method including installing the tubular liner and a first expansion cone in the borehole, injecting a fluidic material into the borehole, pressurizing a portion of an interior region of the tubular liner below the first expansion cone, radially expanding at least a portion of the tubular liner in the borehole by extruding at least a portion of the tubular liner off of the first expansion cone, radially expanding an overlap between the wellbore casing and the tubular liner, and radially expanding the portion of the tubular liner that does not overlap with the wellbore casing using a second expansion cone. In an exemplary embodiment, radially expanding the overlap between the preexisting wellbore casing and the tubular liner includes impulsively applying outwardly directed radial forces to the interior of the overlap between the wellbore casing and the tubular liner. In an exemplary embodiment, impulsively applying outwardly directed radial forces to the interior of the overlap between the wellbore casing and the tubular liner includes detonating a shaped charge within the overlap between the wellbore casing and the tubular liner. In an exemplary embodiment, radially expanding the overlap between the wellbore casing and the tubular liner further includes displacing the second expansion cone in a longitudinal direction, and

permitting fluidic materials displaced by the second expansion cone to be removed. In an exemplary embodiment, displacing the second expansion cone in a longitudinal direction includes applying fluid pressure to the second expansion cone. In an exemplary embodiment, radially expanding the overlap between the tubular liner and the wellbore casing using the second expansion cone further includes displacing the second expansion cone in a longitudinal direction, and compressing at least a portion of the subterranean formation using fluid pressure. In an exemplary embodiment, displacing the second expansion cone in a longitudinal direction includes applying fluid pressure to the second expansion cone. In an exemplary embodiment, radially expanding the portion of the tubular liner that does not overlap with the wellbore casing using the second expansion cone includes displacing the second expansion cone in a longitudinal direction, and permitting fluidic materials displaced by the second expansion cone to be removed. In an exemplary embodiment, displacing the second expansion cone in the longitudinal direction includes applying fluid pressure to the second expansion cone. In an exemplary embodiment, radially expanding the portion of the tubular liner that does not overlap with the wellbore casing using the second expansion cone includes displacing the second expansion cone in a longitudinal direction, and compressing at least a portion of the subterranean formation using fluid pressure. In an exemplary embodiment, displacing the second expansion cone in the longitudinal direction includes applying fluid pressure to the second expansion cone. In an exemplary embodiment, the apparatus further includes injecting a hardenable fluidic sealing material into an annulus between the tubular liner and the borehole.

An apparatus has also been described that includes a first tubular member, and a second tubular member overlappingly coupled to the first tubular member, wherein the inside diameter of the portion of the first tubular member that does not overlap with the second tubular member is substantially equal to the inside diameter of the second tubular member, and wherein the second tubular member is coupled to the first tubular member by a method that includes installing the second tubular member and a first expansion cone in the first tubular member, injecting a fluidic material into the first tubular member, pressurizing a portion of an interior region of the second tubular member below the first expansion cone, radially expanding at least a portion of the second tubular member in the first tubular member by extruding at least a portion of the tubular liner off of the first expansion cone, radially expanding an overlap between the first and second tubular members, and radially expanding the portion of the second tubular member that does not overlap with the first tubular member using a second expansion cone. In an exemplary embodiment, radially expanding the overlap between

the first and second tubular members includes impulsively applying outwardly directed radial forces to the interior of the overlap between the first and second tubular members. In an exemplary embodiment, impulsively applying outwardly directed radial forces to the interior of the overlap between the first and second tubular members includes detonating a shaped charge within the overlap between the first and second tubular members. In an exemplary embodiment, radially expanding the overlap between the first and second tubular members further includes displacing the second expansion cone in a longitudinal direction, and permitting fluidic materials displaced by the second expansion cone to be removed. In an exemplary embodiment, displacing the second expansion cone in a longitudinal direction includes applying fluid pressure to the second expansion cone. In an exemplary embodiment, radially expanding the overlap between the first and second tubular members further includes displacing the second expansion cone in a longitudinal direction, and compressing at least a portion of the subterranean formation using fluid pressure. In an exemplary embodiment, displacing the second expansion cone in a longitudinal direction includes applying fluid pressure to the second expansion cone. In an exemplary embodiment, radially expanding the portion of the second tubular member that does not overlap with the first tubular members using the second expansion cone includes displacing the second expansion cone in a longitudinal direction, and permitting fluidic materials displaced by the second expansion cone to be removed. In an exemplary embodiment, displacing the second expansion cone in the longitudinal direction includes applying fluid pressure to the second expansion cone.

Although illustrative embodiments of the invention have been shown and described, a wide range of modification, changes and substitution is contemplated in the foregoing disclosure. In some instances, some features of the present invention may be employed without a corresponding use of the other features. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the scope of the invention.

Claims

1. An apparatus, comprising:

a first tubular member; and

a second tubular member overlappingly coupled to the first tubular member;

wherein the inside diameter of the portion of the first tubular member that does not overlap with the second tubular member is substantially equal to the inside diameter of the second tubular member; and

wherein the second tubular member is coupled to the first tubular member by a method comprising:

installing the second tubular member and a first expansion device in the first tubular member;

injecting a fluidic material into the first tubular member;

pressurizing a portion of an interior region of the second tubular member below the first expansion device;

radially expanding at least a portion of the second tubular member in the first tubular member by extruding at least a portion of the tubular liner off of the first expansion device;

radially expanding an overlap between the first and second tubular members; and

radially expanding the portion of the second tubular member that does not overlap with the first tubular member using a second expansion device.

2. The apparatus of claim 1, wherein radially expanding the overlap between the first and second tubular members comprises:

impulsively applying outwardly directed radial forces to the interior of the overlap between the first and second tubular members.

3. The apparatus of claim 2, wherein impulsively applying outwardly directed radial forces to the interior of the overlap between the first and second tubular members, comprises:

detonating a shaped charge within the overlap between the first and second tubular members.

4. The apparatus of claim 2, wherein radially expanding the overlap between the first and second tubular members further comprises:

displacing the second expansion device in a longitudinal direction; and

permitting fluidic materials displaced by the second expansion device to be removed.

5. The apparatus of claim 4, wherein displacing the second expansion device in a longitudinal direction comprises:

applying fluid pressure to the second expansion device.

6. The apparatus of claim 2, wherein radially expanding the overlap between the first and second tubular members further comprises:

displacing the second expansion device in a longitudinal direction; and compressing at least a portion of the subterranean formation using fluid pressure.

7. The apparatus of claim 6, wherein displacing the second expansion device in a longitudinal direction comprises:

applying fluid pressure to the second expansion device.

8. The apparatus of claim 1, wherein radially expanding the portion of the second tubular member that does not overlap with the first tubular members using the second expansion device comprises:

displacing the second expansion device in a longitudinal direction; and permitting fluidic materials displaced by the second expansion device to be removed.

9. The apparatus of claim 8, wherein displacing the second expansion device in the longitudinal direction comprises:

applying fluid pressure to the second expansion device.

10. The apparatus of claim 1, wherein the first tubular member comprises a wellbore casing; wherein the second tubular member comprises a wellbore casing; and wherein the first and second tubular members are positioned within a wellbore that traverses a subterranean formation.

11. The apparatus of claim 10, further comprising:

injecting a hardenable fluidic sealing material into an annulus defined between at least one of the first and second tubular members and the borehole.

12. An apparatus, comprising: a first tubular member; and a second tubular member overlappingly coupled to the first tubular member;

wherein the inside diameter of the portion of the first tubular member that does not overlap with the second tubular member is substantially equal to the inside diameter of the second tubular member; and

wherein the second tubular member is coupled to the first tubular member by a method comprising:

installing the second tubular member and a first expansion device in the first tubular member;

radially expanding at least a portion of the second tubular member in the first tubular member using the first expansion device;

radially expanding an overlap between the first and second tubular members; and

radially expanding the portion of the second tubular member that does not overlap with the first tubular member using a second expansion device.

Original claims - not for examination

1. A method of creating a mono-diameter wellbore casing in a borehole located in a subterranean formation including a preexisting wellbore casing, comprising:

installing a tubular liner and a first expansion cone in the borehole;

injecting a fluidic material into the borehole;

pressurizing a portion of an interior region of the tubular liner below the first expansion cone;

radially expanding at least a portion of the tubular liner in the borehole by extruding at least a portion of the tubular liner off of the first expansion cone;

radially expanding an overlap between the preexisting wellbore casing and the tubular liner; and

radially expanding the portion of the tubular liner that does not overlap with the preexisting wellbore casing using a second expansion cone.

2. The method of claim 1, wherein radially expanding the overlap between the preexisting wellbore casing and the tubular liner comprises:

impulsively applying outwardly directed radial forces to the interior of the overlap between the preexisting wellbore casing and the tubular liner.

3. The method of claim 2, wherein impulsively applying outwardly directed radial forces to the interior of the overlap between the preexisting wellbore casing and the tubular liner, comprises:

detonating a shaped charge within the overlap between the preexisting wellbore casing and the tubular liner.

4. The method of claim 2, wherein radially expanding the overlap between the preexisting wellbore casing and the tubular liner further comprises:

displacing the second expansion cone in a longitudinal direction; and

permitting fluidic materials displaced by the second expansion cone to be removed.

5. The method of claim 4, wherein displacing the second expansion cone in a longitudinal direction comprises:

applying fluid pressure to the second expansion cone.

6. The method of claim 2, wherein radially expanding the overlap between the tubular liner and the preexisting wellbore casing using the second expansion cone further comprises:

displacing the second expansion cone in a longitudinal direction; and

compressing at least a portion of the subterranean formation using fluid pressure.

7. The method of claim 6, wherein displacing the second expansion cone in a longitudinal direction comprises:

applying fluid pressure to the second expansion cone.

8. The method of claim 1, wherein radially expanding the portion of the tubular liner that does not overlap with the preexisting wellbore casing using the second expansion cone comprises:

displacing the second expansion cone in a longitudinal direction; and

permitting fluidic materials displaced by the second expansion cone to be removed.

9. The method of claim 8, wherein displacing the second expansion cone in the longitudinal direction comprises:

applying fluid pressure to the second expansion cone.

10. The method of claim 1, wherein radially expanding the portion of the tubular liner that does not overlap with the preexisting wellbore casing using the second expansion cone comprises:

displacing the second expansion cone in a longitudinal direction; and

compressing at least a portion of the subterranean formation using fluid pressure.

11. The method of claim 10, wherein displacing the second expansion cone in the longitudinal direction comprises:

applying fluid pressure to the second expansion cone.

12. The method of claim 1, further comprising:

injecting a hardenable fluidic sealing material into an annulus between the tubular liner and the borehole.

13. A system for creating a mono-diameter wellbore casing in a borehole located in a subterranean formation including a preexisting wellbore casing, comprising:

means for installing a tubular liner and a first expansion cone in the borehole;

means for injecting a fluidic material into the borehole;

means for pressurizing a portion of an interior region of the tubular liner below the first expansion cone;

means for radially expanding at least a portion of the tubular liner in the borehole by extruding at least a portion of the tubular liner off of the first expansion cone;

means for radially expanding an overlap between the preexisting wellbore casing and the tubular liner; and

means for radially expanding the portion of the tubular liner that does not overlap with the preexisting wellbore casing using a second expansion cone.

14. The system of claim 13, wherein the means for radially expanding the overlap between the preexisting wellbore casing and the tubular liner comprises:

means for impulsively applying outwardly directed radial forces to the interior of the overlap between the preexisting wellbore casing and the tubular liner.

15. The system of claim 14, wherein the means for impulsively applying outwardly directed radial forces to the interior of the overlap between the preexisting wellbore casing and the tubular liner, comprises:

means for detonating a shaped charge within the overlap between the preexisting wellbore casing and the tubular liner.

16. The system of claim 14, wherein the means for radially expanding the overlap between the preexisting wellbore casing and the tubular liner further comprises:

displacing the second expansion cone in a longitudinal direction; and

permitting fluidic materials displaced by the second expansion cone to be removed.

17. The system of claim 16, wherein the means for displacing the second expansion cone in a longitudinal direction comprises:

means for applying fluid pressure to the second expansion cone.

18. The system of claim 14, wherein the means for radially expanding the overlap between the tubular liner and the preexisting wellbore casing using the second expansion cone further comprises:

means for displacing the second expansion cone in a longitudinal direction; and

means for compressing at least a portion of the subterranean formation using fluid pressure.

19. The system of claim 18, wherein the means for displacing the second expansion cone in a longitudinal direction comprises:

means for applying fluid pressure to the second expansion cone.

20. The system of claim 13, wherein the means for radially expanding the portion of the tubular liner that does not overlap with the preexisting wellbore casing using the second expansion cone comprises:

means for displacing the second expansion cone in a longitudinal direction; and

means for permitting fluidic materials displaced by the second expansion cone to be removed.

21. The system of claim 20, wherein the means for displacing the second expansion cone in the longitudinal direction comprises:

means for applying fluid pressure to the second expansion cone.

22. The system of claim 13, wherein the means for radially expanding the portion of the tubular liner that does not overlap with the preexisting wellbore casing using the second expansion cone comprises:

means for displacing the second expansion cone in a longitudinal direction; and

means for compressing at least a portion of the subterranean formation using fluid pressure.

23. The system of claim 22, wherein the means for displacing the second expansion cone in the longitudinal direction comprises:

means for applying fluid pressure to the second expansion cone.

24. The system of claim 13, further comprising:

means for injecting a hardenable fluidic sealing material into an annulus between the tubular liner and the borehole.

25. A method of creating a tubular structure having a substantially constant inside diameter, comprising:

installing a first tubular member and a first expansion cone within a second tubular member;

injecting a fluidic material into the second tubular member;

pressurizing a portion of an interior region of the first tubular member below the first expansion cone;

radially expanding at least a portion of the first tubular member in the second tubular member by extruding at least a portion of the first tubular member off of the first expansion cone;

radially expanding an overlap between the first and second tubular members; and

radially expanding the portion of the first tubular member that does not overlap with the second tubular member using a second expansion cone.

26. The method of claim 25, wherein radially expanding the overlap between the first and second tubular members comprises:

impulsively applying outwardly directed radial forces to the interior of the overlap between the first and second tubular members.

27. The method of claim 26, wherein impulsively applying outwardly directed radial forces to the interior of the overlap between the first and second tubular members, comprises:

detonating a shaped charge within the overlap between the first and second tubular members.

28. The method of claim 26, wherein radially expanding the overlap between the first and second tubular members further comprises:

displacing the second expansion cone in a longitudinal direction; and

permitting fluidic materials displaced by the second expansion cone to be removed.

29. The method of claim 28, wherein displacing the second expansion cone in a longitudinal direction comprises:

applying fluid pressure to the second expansion cone.

30. The method of claim 26, wherein radially expanding the overlap between the first and second tubular members using the second expansion cone further comprises:

displacing the second expansion cone in a longitudinal direction; and

compressing at least a portion of the subterranean formation using fluid pressure.

31. The method of claim 30, wherein displacing the second expansion cone in a longitudinal direction comprises:

applying fluid pressure to the second expansion cone.

32. The method of claim 25, wherein radially expanding the portion of the first tubular member that does not overlap with the second tubular member using the second expansion cone comprises:

displacing the second expansion cone in a longitudinal direction; and

permitting fluidic materials displaced by the second expansion cone to be removed.

33. The method of claim 32, wherein displacing the second expansion cone in the longitudinal direction comprises:

applying fluid pressure to the second expansion cone.

34. A system for creating a tubular structure having a substantially constant inside diameter, comprising:

means for installing a first tubular member and a first expansion cone within a second tubular member;

means for injecting a fluidic material into the second tubular member;

means for pressurizing a portion of an interior region of the first tubular member below the first expansion cone;

means for radially expanding at least a portion of the first tubular member in the second tubular member by extruding at least a portion of the first tubular member off of the first expansion cone;

means for radially expanding an overlap between the first and second tubular members; and

means for radially expanding the portion of the first tubular member that does not overlap with the second tubular member using a second expansion cone.

35. The system of claim 34, wherein the means for radially expanding the overlap between the first and second tubular members comprises:

means for impulsively applying outwardly directed radial forces to the interior of the overlap between the first and second tubular members.

36. The system of claim 35, wherein the means for impulsively applying outwardly directed radial forces to the interior of the overlap between the first and second tubular members, comprises:

means for detonating a shaped charge within the overlap between the first and second tubular members.

37. The system of claim 35, wherein the means for radially expanding the overlap between the first and second tubular members further comprises:

means for displacing the second expansion cone in a longitudinal direction; and

means for permitting fluidic materials displaced by the second expansion cone to be removed.

38. The system of claim 37, wherein the means for displacing the second expansion cone in a longitudinal direction comprises:

means for applying fluid pressure to the second expansion cone.

39. The system of claim 35, wherein the means for radially expanding the overlap between the first and second tubular members using the second expansion cone further comprises:

means for displacing the second expansion cone in a longitudinal direction; and

means for compressing at least a portion of the subterranean formation using fluid pressure.

40. The system of claim 39, wherein the means for displacing the second expansion cone in a longitudinal direction comprises:

means for applying fluid pressure to the second expansion cone.

41. The system of claim 34, wherein the means for radially expanding the portion of the first tubular member that does not overlap with the second tubular member using the second expansion cone comprises:

means for displacing the second expansion cone in a longitudinal direction; and

means for permitting fluidic materials displaced by the second expansion cone to be removed.

42. The system of claim 41, wherein the means for displacing the second expansion cone in the longitudinal direction comprises:

means for applying fluid pressure to the second expansion cone.

43. An apparatus, comprising:

a subterranean formation including a borehole;

a wellbore casing coupled to the borehole; and

a tubular liner overlappingly coupled to the wellbore casing;

wherein the inside diameter of the portion of the wellbore casing that does not overlap with the tubular liner is substantially equal to the inside diameter of the tubular liner; and

wherein the tubular liner is coupled to the wellbore casing by a method comprising:

installing the tubular liner and a first expansion cone in the borehole;

injecting a fluidic material into the borehole;

pressurizing a portion of an interior region of the tubular liner below the first expansion cone;

radially expanding at least a portion of the tubular liner in the borehole by extruding at least a portion of the tubular liner off of the first expansion cone;

radially expanding an overlap between the wellbore casing and the tubular liner; and

radially expanding the portion of the tubular liner that does not overlap with the wellbore casing using a second expansion cone.

44. The apparatus of claim 43, wherein radially expanding the overlap between the preexisting wellbore casing and the tubular liner comprises:

impulsively applying outwardly directed radial forces to the interior of the overlap between the wellbore casing and the tubular liner.

45. The apparatus of claim 44, wherein impulsively applying outwardly directed radial forces to the interior of the overlap between the wellbore casing and the tubular liner, comprises:

detonating a shaped charge within the overlap between the wellbore casing and the tubular liner.

46. The apparatus of claim 44, wherein radially expanding the overlap between the wellbore casing and the tubular liner further comprises:

displacing the second expansion cone in a longitudinal direction; and

permitting fluidic materials displaced by the second expansion cone to be removed.

47. The apparatus of claim 46, wherein displacing the second expansion cone in a longitudinal direction comprises:

applying fluid pressure to the second expansion cone.

48. The apparatus of claim 44, wherein radially expanding the overlap between the tubular liner and the wellbore casing using the second expansion cone further comprises:

displacing the second expansion cone in a longitudinal direction; and

compressing at least a portion of the subterranean formation using fluid pressure.

49. The apparatus of claim 48, wherein displacing the second expansion cone in a longitudinal direction comprises:

applying fluid pressure to the second expansion cone.

50. The apparatus of claim 43, wherein radially expanding the portion of the tubular liner that does not overlap with the wellbore casing using the second expansion cone comprises:

displacing the second expansion cone in a longitudinal direction; and

permitting fluidic materials displaced by the second expansion cone to be removed.

51. The apparatus of claim 50, wherein displacing the second expansion cone in the longitudinal direction comprises:

applying fluid pressure to the second expansion cone.

52. The apparatus of claim 43, wherein radially expanding the portion of the tubular liner that does not overlap with the wellbore casing using the second expansion cone comprises:

displacing the second expansion cone in a longitudinal direction; and

compressing at least a portion of the subterranean formation using fluid pressure.

53. The apparatus of claim 52, wherein displacing the second expansion cone in the longitudinal direction comprises:

applying fluid pressure to the second expansion cone.

54. The apparatus of claim 43, further comprising:

injecting a hardenable fluidic sealing material into an annulus between the tubular liner and the borehole.

55. An apparatus, comprising:

a first tubular member; and

a second tubular member overlappingly coupled to the first tubular member;

wherein the inside diameter of the portion of the first tubular member that does not overlap with the second tubular member is substantially equal to the inside diameter of the second tubular member; and

wherein the second tubular member is coupled to the first tubular member by a method comprising:

installing the second tubular member and a first expansion cone in the first tubular member;

injecting a fluidic material into the first tubular member;

pressurizing a portion of an interior region of the second tubular member below the first expansion cone;

radially expanding at least a portion of the second tubular member in the first tubular member by extruding at least a portion of the tubular liner off of the first expansion cone;

radially expanding an overlap between the first and second tubular members; and

radially expanding the portion of the second tubular member that does not overlap with the first tubular member using a second expansion cone.

56. The apparatus of claim 55, wherein radially expanding the overlap between the first and second tubular members comprises:

impulsively applying outwardly directed radial forces to the interior of the overlap between the first and second tubular members.

57. The apparatus of claim 56, wherein impulsively applying outwardly directed radial forces to the interior of the overlap between the first and second tubular members, comprises:

detonating a shaped charge within the overlap between the first and second tubular members.

58. The apparatus of claim 56, wherein radially expanding the overlap between the first and second tubular members further comprises:

displacing the second expansion cone in a longitudinal direction; and

permitting fluidic materials displaced by the second expansion cone to be removed.

59. The apparatus of claim 58, wherein displacing the second expansion cone in a longitudinal direction comprises:

applying fluid pressure to the second expansion cone.

60. The apparatus of claim 56, wherein radially expanding the overlap between the first and second tubular members further comprises:

displacing the second expansion cone in a longitudinal direction; and

compressing at least a portion of the subterranean formation using fluid pressure.

61. The apparatus of claim 60, wherein displacing the second expansion cone in a longitudinal direction comprises:

applying fluid pressure to the second expansion cone.

62. The apparatus of claim 55, wherein radially expanding the portion of the second tubular member that does not overlap with the first tubular members using the second expansion cone comprises:

displacing the second expansion cone in a longitudinal direction; and

permitting fluidic materials displaced by the second expansion cone to be removed.

63. The apparatus of claim 62, wherein displacing the second expansion cone in the longitudinal direction comprises:

applying fluid pressure to the second expansion cone.

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Application No: GB0503470.7 43 **Examiner:** Alan Jones

Claims searched: 1-12 **Date of search:** 18 March 2005

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X,P	1, 4, 8 & 10-12	WO02/068792 A1 (ENVENTURE GLOBAL TECH) See e.g. figures 4-8
X,E	1, 4, 8 & 10-12	GB2399579 A (ENVENTURE GLOBAL TECH) See e.g. figures 4-8

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